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AT HARVARD COLLEGE.
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NEW FOSSIL MAMMALS FROM CUBA.

By G. M. Allen.

With One Plate.

CAMBRIDGE, MASS., U. S. A.:
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No. 1.— *New Fossil Mammals from Cuba.*

By Glover M. Allen.

The recent discoveries of fossil mammals in Porto Rico, San Domingo, and Cuba (Anthony, 1916, 1916a; Miller, 1916a) indicate the former existence in these islands of a very interesting and remarkable assemblage of indigenous species many of which have probably become extinct within only very recent times. The remains hitherto discovered represent five extinct genera of hystricine rodents (not including Amblyrhiza of Anguilla and St. Martin's), at least two genera of ground sloths, and a new family of insectivores (Nesophontidae). Further systematic search will doubtless disclose additional remains on other of the Antillean islands, the study of which must throw much light on the distributional problems of the West Indies.

The Museum of Comparative Zoölogy has received from Professor Carlos de la Torre, the distinguished Cuban naturalist, a fragment of bone-breccia obtained in the Province of Matanzas, Cuba, from a '*caverna*' — cleft or cavity as distinguished from '*cueva*,' a large cave. This block is less than one fourth of a cubic foot in volume, and apparently represents a complete section of the floor deposit, some four inches thick. The bottom portion consists of red cave earth, and a few limestone pebbles with much admixture of minute bone-fragments. The more superficial portion is almost entirely composed of small mammalian bones, indistinctly stratified, for the greater part crushed to microscopic fragments. The whole mass is mixed with particles of cave earth, and solidly cemented together by the deposition of lime from infiltrating water. As to the age of the deposit, there is of course no indication beyond the fact of its having been laid down in a cavern of no great antiquity. Presumably it is of Pleistocene or even more recent age.

In spite of the very fragmentary nature of the bones, and the solidity with which they were cemented together, a number of nearly complete jaws and palates were extricated. Lower jaws, as usual in such deposits, are best preserved and most frequent; portions of long bones, though common, were usually too broken to be of value. A careful study of the jaws and teeth recovered, reveals three very interesting new species. The first is an insectivore of a type probably related to the newly described Nesophontes of Porto Rico. It is, however, a much smaller animal, and is likely to prove a representative of still another genus, though on account of the fragmentary nature of the only jaw discovered, this is still uncertain. The two other species are hystricine rodents, the one a small mouse-like species, probably related to Brotomys and Boromys (Miller, 1916a), the other a member of the short-tailed group of Capromys, for which Chapman (1901) proposed the subgenus Geocapromys. The last species forms by far the greater part of the bone fragments.

The subgenus Geocapromys has hitherto been known from three living forms only — *brownii*, *thoracatus*, and *ingrahami*, confined respectively to Jamaica, Little Swan Island, and Plana Keys (Bahamas). The discovery of a recently extinct species in Cuba is therefore important, as bridging in part the hiatus between the last two species, and definitely adding Cuba to the known range of the group. A study of all the living species of Capromys as at present understood, reveals an excellent tooth character by which the short-tailed members of the group may be distinguished, namely, the presence of an additional antero-internal reentrant in the enamel pattern of the first lower molariform tooth (pm_4). This, in addition to other cranial and external characters, in part already pointed out by Chapman, is, I think, sufficient to raise Geocapromys to generic rank, as a related but more specialized group.

In working out the relations of the Cuban Geocapromys, it became necessary to consider more carefully Chapman's *Capromys columbianus*. This was described on the basis of two subfossil fragments of the maxillary with the palate, found in a cave near Trinidad, Cuba, buried a few inches from the surface. Associated with these were a molar (probably the last one in an upper series) and portions of bones which were doubtfully referred to the same species. The molar is, without much question, from a species of Capromys, but Chapman's excellent figure and description leave no doubt that his *C. columbianus* is an animal very different from other known forms of that genus. Indeed, as I have previously suggested (1911, p. 212) it is not even congeneric. Through the kindness of Mr. H. E. Anthony of the American Museum of Natural History, I have lately had the privilege of examining the type specimens and find my previous conclusions fully substantiated. In order to bring out more clearly the peculiarities of this animal, and to obviate any misconceptions of distribution that may arise through considering it a fourth Cuban species of Capromys, I therefore propose for it a new generic term:

SYNODONTOMYS, gen. nov.

Type Species.— *Capromys columbianus* Chapman (1892, p. 314, fig. 3).

Generic Characters.— A Capromys-like animal of the size of *C. pilorides*, with a V-shaped palate that narrows anteriorly until the anteriormost molariform teeth (*pm^4*) nearly touch the median axis, and are only separated from each other by the thin bony walls of their alveoli. Pattern of upper cheek teeth apparently similar to that of Capromys, with two outer reentrant folds of enamel and one median inner fold; but apparently these folds slope rather strongly forward (as indicated by the forward direction of the small vertical ridges of the alveoli) instead of being as in Capromys nearly transverse. In outline the molariform teeth are very nearly square instead of elongate or rectangular as in Capromys, and are subequal in size.

In the close approximation of the maxillary tooth rows, this genus recalls Myocastor, but differs in the tooth structure.

The three species found among the fragments in the block of bone-breccia from Matanzas are the following.

INSECTIVORA.

?NESOPHONTES MICRUS, sp. nov.

Plate, fig. 14.

Type.— A posterior half of the right ramus, containing a part of pm_4, m_1, m_2, and the roots of m_3, M. C. Z. 9600. From a cavern in the Sierra of Hato-Nuevo, Province of Matanzas, Cuba. Carlos de la Torre.

Description.— The fragment indicates an animal considerably smaller than *Nesophontes edithae* of Porto Rico, but the jaw was evidently similar in the general form of the angulare and the ascending process. The ramus, however, seems proportionally more slender, without the depth of curve beneath the molars. The molars differ from those of the type species of Nesophontes (1) in being less elongate in the axis of the tooth row; (2) in decreasing in size from m_1 to m_3; (3) in lacking a certain 'plumpness' of form that is found in Solenodon as well; and (4) in the lack of a space between the posterior border of m_3 and the ascending process of the mandible.

The fragment contains traces of two roots of a pm_3, and a nearly complete pm_4 which, as in *N. edithae*, is two-rooted with a prominent posterior cingulum cusp. Both first and second lower molars have a cingulum on the anterior half of the outer aspect. Their cusps are sharp, the paraconid equalling the hypoconid in vertical height. The protoconid is higher than the metaconid, which it nearly hides in side view, though its summit is a very little posterior to that of the metaconid. The entoconid and the hypoconid are of equal height, the former very slightly anterior to the latter in side view (Plate, fig. 14). There seems to be also a minute hypoconulid. The condyle of the jaw is not in condition for thorough comparison.

Measurements.— Front of pm_4 to ascending process of mandible, 7.5 mm.; front of pm_4 to back of m_2, 5.5; length of m_1, 2.3; of m_2, 2.0; depth of ramus at front of m_2, 2.4.

Specimen examined.— The type.

Remarks.— While agreeing in the general structure of the teeth so far as this can be determined from the specimen, there are such evident differences of proportion and size as to render it unlikely that this jaw is from a species of Nesophontes. Nevertheless the similarity is sufficient to associate it with that genus until better material may be discovered to prove its relationships are otherwise. Certainly the present fragment is insufficient for the founding of still another genus. The teeth are of a rather primitive type and clearly indicate a fourth species of Antillean insectivore.

RODENTIA.

Boromys torrei, sp. nov.

Plate, fig. 10–13.

Type.— A palate with root of right zygomatic arch, pm^4 and alveolar row of right side, m^1 and posterior part of alveolar row of left side, M. C. Z. 9601. From a cavern in the Sierra of Hato-Nuevo, Province of Matanzas, Cuba. Carlos de la Torre.

Description.— Resembles *Brotomys voratus* of San Domingo and *Boromys offella* of Cuba, but differs from both in its much smaller size and the deeper indentation of the posterior emargination of the palate, which reaches forward to the level of the center of m^2. It is not possible to determine whether there is a supplemental groove at the base of the antorbital foramen, the chief cranial character distinguishing Boromys from Brotomys. In the tooth pattern, however, the type specimen seems to correspond more nearly to the description of Boromys, to which I shall provisionally refer it.

The essential feature of the molars in both genera is probably the same, though Boromys, so far as at present known, seems to have deeper anterior secondary folds of the enamel. The upper molars have each a deep median enamel fold on the inner and the outer side, that meet at the middle of the tooth. The anterior half has another fold from the exterior, which though extending a trifle beyond the median line of the tooth, is of less vertical extent than the primary fold. The posterior half has a similar secondary fold extending inward from the palatal side of the tooth. As Miller points out, the posterior secondary fold is smaller than the anterior, so that the minute enamel lake to which it eventually is reduced by wear, disappears before the anterior lake, a condition which appears to obtain in the type here described. In this specimen the second molariform tooth, m^1, is more worn than the first, pm^4, so that it has a large lake of enamel in its anterior half and a smaller round one in its posterior, whereas pm^4 has the anterior secondary fold still strongly connected with the external enamel wall, while the posterior secondary fold is reduced to a small round dot. Both these upper teeth are slightly everted. In the empty alveoli, the cavities of three roots are seen, two anterior, and a third posterior occupying the breadth of the cavity. The anterior edge of pm^4 is on a level with the posterior edge of the zygomatic root.

In addition to the type palate, several lower jaws were found, which though dissociated, unquestionably belong to this species. All are of uniform size. The lower incisor is strong, its base curving back and out, to end slightly above and external to the alveolar row of the molars. Its anterior enamel face is orange-yellow in color, in contrast to the very shining white of the molars. As in the upper molars the outer median enamel fold (Plate, fig. 11) has its tip very slightly posterior to that of the inner fold. A minute round enamel lake is present in both anterior and posterior halves of the first tooth, pm_4, but in the posterior half only of the two succeeding teeth, m_1 and m_2. In this respect the lower molars differ from those of Steiromys, which has a secondary reentrant in the anterior lobe of the molars. None of the specimens shows m_3 in place. Two isolated teeth, evidently lower molars, show clearly that there is no secondary reentrant in the anterior half, but that it is present in the posterior half only (Plate fig. 12).

Measurements. — Alveolar length of upper tooth row, 7.6 mm.; width of alveolus of m^1, 2.1; width of palate outside alveoli of m^1, 6.4; width of palate outside alveoli of m^3, 6.5; length of crown of pm^4, 2.0; of m^1, 1.9; width between alveoli of m^2 (front corners), 2.1; lower jaw, diastema, 4.1; alveolar length of lower tooth row, 7.0; length of pm_4, 2.0; of m_1, 1.7; of m_2, 1.7.

Specimens examined.— The type palate, eight lower jaws, and two separate lower molars.

Remarks.— Notwithstanding the similarity in general structure of the enamel pattern, it is unlikely that this small species will prove to be a member either of Brotomys or Boromys, if indeed the two latter are really as distinct as supposed. The structure of the palate is different in the present form and this coupled with its much less size presupposes further important differences. Until better material is available, however, it may stand provisionally with Boromys. The pattern of the upper molars, as Miller (1916a) remarks is not very different from that of Stichomys and it might be added, of Asteromys.

It is a pleasure to associate with this interesting discovery, the name of Professor de la Torre, whose investigations have so greatly enriched our knowledge of the natural history of Cuba.

The second species of rodent discovered, belongs to the group of short-tailed Capromys-like animals, a group to which I here assign generic rank. It may be defined as follows.

GEOCAPROMYS Chapman (1901, p. 314).

Type Species.— By selection, *Capromys brownii* Fischer.

Generic Characters.— Like Capromys, but the tail little, if any longer than the hind foot with claws; the thumb much more reduced so as to be scarcely evident. The most important cranial character is the presence of an additional antero-internal enamel fold in the first lower cheek-tooth, making three evident reentrants on the lingual side, instead of two, as in Capromys, a character which in view of the relatively small amount of variation in the enamel pattern of the two genera, assumes here considerable importance (Plate, fig. 1–6, 8). In addition, the upper tooth rows are more strongly convergent anteriorly and the zygomatic portion of the maxillary is broader than in Capromys.

Three living species are included in this genus. Of these, *Geocapromys brownii*, of Jamaica, is the largest. The two others, *G. thoraca-*

tus of Little Swan Island, and *G. ingrahami* of Plana Keys, Bahamas, are smaller, and much more resemble each other in their gray type of coloring than they do the large dark brown animal of Jamaica. As Chapman pointed out, these may indicate two species-groups. The recent discovery in Jamaica of fossil jaws indistinguishable from those of *G. thoracatus* (Miller, 1916) may further indicate that both species-groups formerly were represented in that island. An additional character of value is the color of the incisors. These are deep yellow in adults of all species of Capromys. In *Geocapromys brownii* and *ingrahami* they are very pale yellow, almost whitish; while in *G. thoracatus* and the new fossil species described below from Cuba, the incisors are ivory-white. The Cuban species may be known as

GEOCAPROMYS CUBANUS, sp. nov.

Plate, fig. 7–9.

Type.— Portion of the right lower ramus of an immature animal, showing the incisor and three anterior cheek-teeth in place, M. C. Z. 9602. From the Sierra of Hato-Nuevo, Province of Matanzas, Cuba. Carlos de la Torre.

Description.— A species slightly smaller than *G. ingrahami*, but with relatively broader molars, when adult. The reentrants are relatively deeper, narrower, and more nearly parallel-sided, giving the pattern an appearance of greater compression in the direction of the jaw's axis. The anteriormost inner reentrant of pm_4 is relatively deeper than in any of the existing species, and reaches to the mid-line of the tooth (Plate, fig. 8). The incisors are slender and white. The palate (M. C. Z. 9603) shows the strongly contracted tooth rows and narrow median bony ridge characteristic of the genus. The broken condition of the palates discloses the fact that the alveoli of the upper molar rows, though 2 mm. apart at the point where the teeth emerge, are nearly in contact at the upper level of their roots, as if foreshadowing the condition in Synodontomys in which the tooth rows are practically in contact at the level of the palate.

The enamel pattern of adult specimens more nearly resembles that of *G. brownii* of Jamaica than it does either of the other living species. Young individuals have a more open pattern showing less compression and depth of the enamel folds, but intermediate conditions link these extremes in the series at hand. The palate ends at about the level of the middle of m^3, without the median bony projection found in *G. thoracatus*.

Measurements.— Length of lower diastema of type, 7 mm.; of pm_4, 3.1; of m_1, 3; length of lower molar row in an adult, (9604), 14.3; of pm_4, 4; of m_1, 3.5; of m_2, 3.0; width of m_1, in same specimen, 3.7; length of upper molar row (9603), 13.2; distance between tooth rows anteriorly, 1.8; posteriorly, 5.6; width across anterior corners of alveoli of cheek teeth, 7; width of m^1, 3.6.

Specimens examined.— Five palates with teeth, about 15 jaw fragments mostly with teeth, and numerous other fragments.

Remarks.— The relationship of the fossil Cuban Geocapromys, seems on the whole to be with *G. brownii* in the relatively broad molars with their deep, compressed enamel folds. It is nearer *G. ingrahami* in size, though even smaller; and further resembles that species in the form of the terminal part of the bony palate, which is arched and lacks the distinct median projection seen in *G. thoracatus*. The remains of this extinct Cuban species compose most of the original block of bone-breccia which forms the subject of this paper. The bones are so greatly broken, however, that it was impossible to extricate any except the dental portions of the skull and a few ear bullae.

GENERAL REMARKS.

While it is premature to speculate on the significance of the recently discovered fossil mammals in Cuba, Porto Rico, and San Domingo, it is clear that the additional facts of distribution tend to confirm the evidence for a former continuity of the Greater Antillean land masses. Thus Geocapromys is now known from Little Swan Island, Jamaica, Cuba, and Plana Keys, with probably two types in Jamaica. A Cuban insectivore related to the fossil Nesophontes of Porto Rico parallels the presence of Solenodon on Cuba and San Domingo. The Isolobodon of Porto Rico is indistinguishable from that of San Domingo. Related genera of rodents — Brotomys and Boromys — are found to occur in San Domingo and Cuba respectively. These, and other cases among reptiles (Barbour, 1914), birds, and mammals seem to imply a consistent rather than a haphazard method of distribution, the most obvious explanation of which seems to be that the Antillean land mass was formerly of larger extent and that the several islands now representing it were once connected. The dismemberment of this hypothetical land mass into islands, whether by depression, by the erosion of ocean currents, or by other geological processes, has separated members of a once more homogeneous fauna, and through long isolation they have in many cases developed racial variations on the different islands.

The time is not ripe for conclusions as to the place and method of origin of the West Indian fauna. The evidence of fossil mammals is still inconclusive. For while the numerous species and genera of sloths and hystricine rodents recall strongly the characteristic South American forms, the hystricines are of wide distribution in both hemispheres, and insectivores are, so far as known, wholly absent from South America until very recent times. Nevertheless the more obvious view seems to be that the mammal fauna reached these areas at a rather remote time, perhaps in part as more primitive types in a retreat before a fauna of more specialized invaders from a northern center of distribution, as argued so ably by Matthew (1915). A severance of land connections with the continent would be then postulated, so that the ancient fauna might survive apart from further competition with more modern forms.

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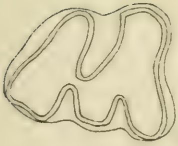
EXPLANATION OF THE PLATE.

EXPLANATION OF THE PLATE.

(All figures drawn with camera lucida).

Figs. 1–3.— First lower cheek-tooth (pm_4) of Capromys, right side.
  Fig. 1.— *Capromys prehensilis.* × 5.
  Fig. 2.— *C. pilorides.* × 5.
  Fig. 3.— *C. melanurus.* × 5.
Figs. 4–6, 8. First lower cheek-tooth (pm_4) of Geocapromys, right side.
  Fig. 4.— *Geocapromys brownii.* × 5.
  Fig. 5.— *G. thoracatus.* × 5.
  Fig. 6.— *G. ingrahami.* × 5.
  Fig. 8.— *G. cubanus* (immature), from the type. × 6.1.
Fig. 7.— Upper cheek-teeth of *Geocapromys cubanus*, to show enamel pattern. × 5.
Fig. 9.— Lower molars (m_{1-3}) of an adult *G. cubanus.* × 5+.
Fig. 10.— *Boromys torrei*, from the type, showing the form of the palate, the right upper premolar (pm^4) and left upper first molar (m^1). × 3.5.
Fig. 11.— Enamel pattern of the crowns of the three anterior cheek-teeth, lower jaw, of *Boromys torrei.* × 5.
Fig. 12.— A lower molar of *Boromys torrei*, less worn than those in the preceding figure, showing the shallow secondary reentrant. × 5.
Fig. 13.— Fragment of right lower jaw of *Boromys torrei.* × 3.
Fig. 14.— Portion of right lower jaw of ?*Nesophontes micrus*, showing pm_4, m_1, m_2, in place and roots of m_3. From the type. × 2.7.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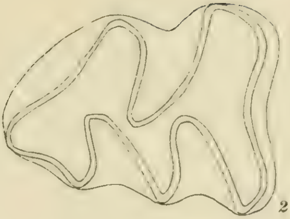
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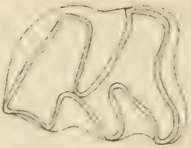
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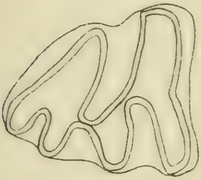
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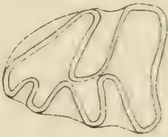
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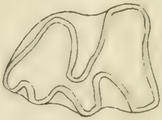
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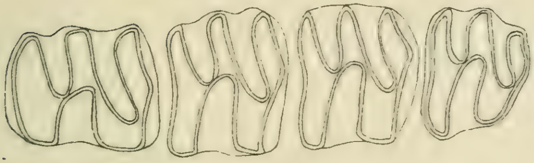
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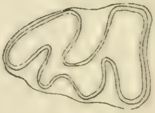
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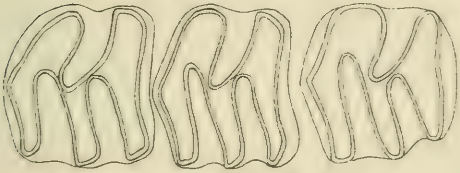
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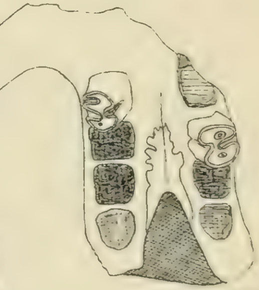
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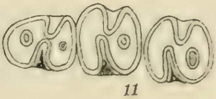
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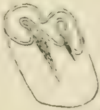
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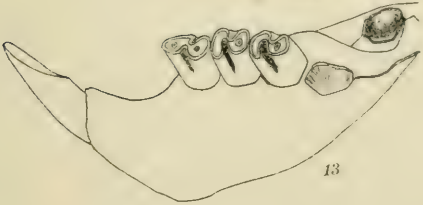
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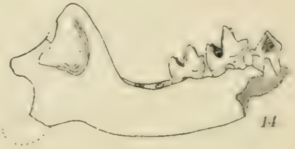
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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXI. No. 2.

THE ANTS OF ALASKA.

By William Morton Wheeler.

CAMBRIDGE, MASS., U. S. A.:
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March, 1917.

No. 2.— *The Ants of Alaska.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY, NO. 126.

By William Morton Wheeler.

Our knowledge of the Formicidae of Alaska has been of very slow growth, probably because most of the collectors who have ventured into that extensive region have found ants too scarce and inconspicuous to merit serious attention. In 1899 Prof. Trevor Kincaid, while accompanying the Harriman Alaska Expedition, secured a number of specimens of five species which were recorded by Pergande (Proc. Wash. acad. sci., 1900, **2**, p. 519–521) as *Formica neorufibarbis* Emery, *Lasius niger* Linné subsp. *sitkaensis* Pergande, *Leptothorax yankee* Emery var. *kincaidi* Pergande, *Myrmica sabuleti* Meinert var. *lobifrons* Pergande and *Myrmica sulcinodoides* Emery. Three of these were new to science, but unfortunately Pergande's descriptions of them are inadequate and puzzling, and although the types (No. 5277–5279) were cited as being in the U. S. N. M., Mr. S. A. Rohwer, after careful search has been unable to find them, and I have failed to find any cotypes in Pergande's private collection, which was acquired by the Museum after his death. Within recent years I have recorded *Myrmica brevinodis* Emery var. *alaskensis* Wheeler, *Formica fusca* Linné var. *gelida* Wheeler and *Camponotus herculeanus* Linné var. *whymperi* Forel from Alaska. During the summer of 1916 Mr. J. A. Kusche of Eldridge, California, kindly collected a considerable number of ants for me in several Alaskan localities and in the adjacent Yukon territory of British America. Among the material I find three forms not hitherto recorded from these regions, so that the total known to date is twelve. They represent, however, only seven species: *Myrmica brevinodis, M. scabrinodis, Leptothorax acervorum, Lasius niger, Formica sanguinea, F. fusca,* and *Camponotus herculeanus,* all well-known from the boreal portions of Europe and Asia, except *Myrmica brevinodis,* which might, in fact, be regarded as a subspecies of the Eurasian *M. sulcinodis.* Four of the varieties seem to be peculiar to Alaska, but all the other forms range widely through British America and southward into the United States along the higher slopes of the Sierra-Cascade and Rocky Mountains. The specimens collected by

Mr. Kusche at Fort Yukon, Nulato, and Rampart (64°–67° N. L.) are of unusual interest, because, with the single exception of the specimens of *Leptothorax kincaidi* taken by Mr. F. H. Whitney on the Upper Kugarok River, near Nome, and recorded in my paper on the mountain ants of western North America (Proc. Amer. acad. sci., 1917, **52**, p. 512), no American ants had previously been found so far north. Fort Yukon, the remotest of the localities, is, in fact, situated on the Arctic Circle, which, I believe, may safely be taken as the extreme northern limit of our ant fauna. Owing to the important bearing of all the elements of the Alaskan biota on questions of geographical distribution and on the question of a former Alaskan-Siberian land-bridge in particular, it seems advisable to publish a brief annotated list of the known Alaskan Formicidae together with a record of the various localities in which they were collected.

1. MYRMICA BREVINODIS Emery var. SULCINODOIDES Emery.

Pergande records this form from Sitka and says that the palest specimens in his series agreed exactly with those he saw from Hill City, South Dakota. The specimen from Homer, Alaska (A. Mehner) referred by me to the var. *frigida* Forel (Bull. Wisc. nat. hist. soc., 1907, **5**, p. 78) may be more properly referred to *sulcinodoides*. Indeed, I doubt whether *frigida* can be maintained as a distinct variety. Forel's var. *whymperi* is also, in my opinion, a synonym of *sulcinodoides* Emery. The latter is known from higher elevations, up to 11,000 feet, in the Rockies of British Columbia, Utah, Colorado, and New Mexico and in the Sierra Nevada. In the paper cited above I called attention to the peculiar greenish yellow color of the larvae of this ant and their oily luster.

2. MYRMICA BREVINODIS var. ALASKENSIS Wheeler.

Recently described from workers taken at Seward, on the Kenai Peninsula by Mr. F. H. Whitney (Proc. Amer. acad. sci., 1917, **52**, p. 503). Numerous specimens from two colonies found by Mr. Kusche at Fort Yukon and in the Pynaw Mts., near Rampart, also belong to this variety.

3. MYRMICA BREVINODIS var. KUSCHEI, var. nov.

Worker. Length 3–3.5 mm.

Very similar in sculpture, pilosity, and color to the var. *alaskensis* but averaging somewhat smaller, with shorter and straight, instead of curved, epinotal spines, the antennal scapes very distinctly broader and flatter at the base and with the middorsal portion of the postpetiole smooth and shining. The clypeus has only about eight coarse longitudinal rugae as in *alaskensis*.

Female (deälated). Length 5.5 mm.

Much darker than the worker, the head, thorax, petiole, postpetiole, and gaster being castaneous, the mandibles, antennae, and legs brownish yellow. Rugae on the body coarse, those on the pronotum very coarse and vermiculate, on the remainder of the thorax longitudinal, finer on the pleurae than on the mesonotum and scutellum. Postpetiole above without a smooth area, sharply, regularly, and concentrically rugose, the rugae transverse at the posterior border. Surface of body distinctly more shining than in the worker; pilosity very similar.

Described from a female and twenty-three workers taken by Mr. Kusche from a single colony at Ketchikan.

The worker and female of this variety are readily distinguished from the corresponding phases of the other described forms of *brevinodis* by the peculiar sculpture of the dorsal surface of the postpetiole, the sculpture in the worker recalling that of *Myrmica scabrinodis* var. *detritinodis* Emery, while the postpetiolar rugae in the females of the other forms are not regular and concentric but longitudinal and irregular or interrupted.

4. MYRMICA SCABRINODIS Nylander subsp. LOBICORNIS Nyl. var. LOBIFRONS Pergande.

Pergande described this form as *M. sabuleti* var. *lobifrons* but his description is so brief as to apply to almost any small Myrmica. He says merely that it measures 3 mm. and is dark brown or black, with the "mandibles, antennae, legs, sides of the thorax and of the abdomen more or less distinctly yellowish brown, reddish brown or almost black," and adds that it is "closely related to a form of *Myrmica sabuleti* inhabiting South Dakota, but is somewhat larger and much darker, with the sculpturing of the head and thorax coarser and the hairs stouter and shorter." He cites no locality for the types (No. 5279, U. S. N. M.), which seem to be lost. As *sabuleti* is itself now regarded as merely a variety of *scabrinodis*, it is clear that *lobifrons* must be referred to some other form. I conjecture that it is a variety of *lobicornis*, which I have recently shown (Proc. Amer. acad. sci., 1917, **52**, p. 504) to be actually represented in America by Forel's var. *glacialis* of the Rocky Mts. and Sierra Nevada. Perhaps *glacialis* is merely a synonym of *lobifrons*, but this can be determined only if Pergande's types are found or by further collecting in Alaska.

5. LEPTOTHORAX ACERVORUM Nylander subsp. CANADENSIS Provancher var. KINCAIDI Pergande.

This variety was described as *L. yankee* Emery var. *kincaidi* from a female and twelve workers taken by Professor Kincaid at Metlakahtla. I have recorded it from the Upper Kugarok River, near Nome (65° N. L.) where it was taken by Mr. F. H. Whitney. Numerous workers taken by Mr. Kusche at Skagway and White Pass agree even more closely with Pergande's description, as they are somewhat smaller and lack the crescentic black spot on the pronotum. Perhaps the more northern specimens should be regarded as a distinct variety.

6. LASIUS NIGER Linné var. SITKAËNSIS Pergande.

This form, not represented among the specimens collected by Mr. Kusche, was described by Pergande as a subspecies of *L. niger* from twenty-five workers taken at Sitka. As stated in my recent paper on the mountain ants, I believe it to be identical with a form which I have found to be common throughout the Canadian zone. Pergande mentions its similarity to *Lasius subniger* of Maine (*recte neoniger* Emery). If I am right in my identification of the Alaskan form it is merely a variety and not a subspecies of the typical Eurasian *niger*.

7. FORMICA SANGUINEA Latreille subsp. SUBNUDA Emery.

Mr. Kusche secured many workers of this subspecies from several colonies at Skagway and White Pass, Alaska and White Horse, Yukon.

All agree with the typical form of the subspecies from the Canadian zone of southern British America and the United States in lacking erect hairs on the thorax and in having only a very few inconspicuous hairs on the dorsal surface of the head. The slaves in several of the colonies were workers of *F. fusca* var. *gelida* and var. *neorufibarbis*. Some of the colonies contained a few small *subnuda* pseudogynes. If Wasmann's and Muckermann's contention is correct, that pseudogynes are produced only as the result of the presence of staphylinid beetles of the tribe Lomechusini (species of *Xenodusa* in North America) in the *sanguinea* nests, we must suppose that these beetles range as far north as Alaska. This has not been demonstrated, so that my suggestion that pseudogynes may also be produced by other causes, is still worthy of consideration, especially as Mr. Horace Donisthorpe writes me that he is also of the opinion that pseudogynes occasionally make their appearance in British *sanguinea* colonies which have never been infested by lomechusine parasites.

8. FORMICA FUSCA Linné.

A number of workers taken by Mr. Kusche at Fort Yukon belong to the typical black form of this species, which is widely distributed, not only in the Canadian zone of North America, as I have shown in previous articles (Bull. M. C. Z., 1913, **53**, p. 496; Proc. Amer. acad. sci., 1917, **52**, p. 545) but also throughout boreal Eurasia as far north as latitude 65°.

9. FORMICA FUSCA var. MARCIDA Wheeler.

I refer to this variety a deälated female and thirty-six workers taken by Mr. Kusche from a single colony at White Horse, Yukon, and a series of workers which he took at Fort Yukon, Alaska. The former are fully as large as the typical *fusca* and have the mandibles, antennae, and legs of an even paler and purer brownish yellow color than in the types which were taken in the Selkirk Mts. of British Columbia, the latter are much more like the types in size and color. This variety has also been taken in Alberta, Manitoba, Washington, and California but always in an alpine environment.

10. Formica fusca var. neorufibarbis Emery.

Under the name *F. neorufibarbis* Pergande included both this and the following variety. I believe that only his specimens from Metlakahtla, which he calls the palest form, belong to *neorufibarbis*, those from Sitka and Kadiak being referable to the var. *gelida*. Mr. Kusche secured several series of workers at Skagway and Ketchikan, Alaska and White Horse, Yukon. The large individuals have the thorax, petiole, and legs uniformly red, without traces of infuscation and are exactly like those taken by myself during the summer of 1915 in the Canadian Rockies and the Sierra Nevada.

11. Formica fusca var. gelida Wheeler.

The study of a long series of workers and deälated females taken by Mr. Kusche at Skagway, Nulato, Ketchikan, and in the Pynaw Mts., near Rampart, Alaska, and at White Horse, Yukon, and of a few workers from Seward (F. H. Whitney) and Kasiloff Lake, on the Kenai Peninsula, shows that this variety cannot be satisfactorily distinguished from *neorufibarbis* except by the color of the larger workers, which in *gelida* have the legs and thorax more or less and often deeply infuscated. Darker specimens seem to pass over into the typical *fusca*, while immature specimens are difficult to distinguish from the var. *marcida*.

12. Camponotus herculeanus Linné var. whymperi Forel.

This variety is not only widely distributed through the Canadian and Hudsonian zones of North America, but is said to occur also in Siberia. Mr. Kusche obtained numerous worker and female specimens from several colonies at Fort Yukon, Skagway, and Nulato, Alaska and White Horse, Yukon. I have also seen specimens from Kasiloff Lake, on the Kenai Peninsula (Berlin Museum) and Koyukuk (W. J. Peters). The variety differs from the typical *herculeanus* merely in the slightly longer and more abundant, subappressed hairs on the tibiae. As I find this character to be inconstant on comparison of American and European specimens, *whymperi* would seem to be an insignificant if not a spurious variety.

Postscript.—Just after correcting the first proof of this paper Mr. S. A. Rohwer informed me that he had succeeded in finding in the U. S. N. M. the types of the varieties of ants described by Pergande from Alaska and that he was sending me paratypes of *Lasius sitkaënsis, Myrmica lobifrons,* and *Leptothorax kincaidi* and a couple of workers identified by Pergande as belonging to *Myrmica sulcinodoides.* The conclusions I have reached from a study of the specimens may be briefly stated:—

(1). *Myrmica brevinodis* var. *sulcinodoides* Emery.— The specimens from Sitka referred by Pergande to this variety differ somewhat in color from the form I regard as typical *sulcinodoides,* as they have the head and gaster dark brown, instead of black, and the remainder of the body and appendages yellowish brown instead of deep red. I should be inclined to refer them to the var. *subalpina* Wheeler, but as Pergande refers to differences of color in his series, the specimens before me may be somewhat immature.

(4). *Myrmica scabrinodis* subsp. *lobicornis* var. *lobifrons* Pergande.— The types and paratypes are from Metlakahtla and the two of the latter received from Mr. Rohwer belong to different species which were not distinguished by Pergande. One is identical with *M. scabrinodis lobicornis* var. *glacialis* Forel as I find by comparison with a cotype from Vermillion Pass, Alberta, received from Professor Forel many years ago. The var. *glacialis* Forel therefore becomes a synonym of *lobifrons* Pergande. The other specimen belongs to *Myrmica brevinodis* and agrees perfectly with the cotypes of the var. *kuschei* described above. That Pergande really based his variety on a specimen with the antennal scape toothed at the base, is shown by his attaching the form to *Myrmica sabuleti.*

(5). *Leptothorax acervorum* subsp. *canadensis* var. *kincaidi* Pergande. Two worker paratypes from Metlakahtla agree closely with the specimens recorded above from Skagway and White Pass in size, form, and sculpture, but the latter have the light portions of the body and appendages paler and more reddish and there are no traces of infuscation on the thoracic dorsum and the summits of the petiolar and postpetiolar nodes. The Pergande specimens also have the legs without the short, erect or suberect hairs which are clearly visible in the specimens taken by Mr. Kusche. The latter, therefore, are more like the typical *canadensis.*

(6). *Lasius niger* var. *sitkaënsis* Pergande.— The interpretation of this variety given in my recent paper, "The mountain ants of western North America" (Proc. Amer. acad. sci. 1917, 52, p. 524), is shown by a study of two paratypes to be correct. The paratypes are somewhat larger and darker than most of the specimens in my collection from boreal portions of the United States and British America, but series from Flathead Lake, Montana and Pullman, Washington are almost identical in size and coloration with the paratypes from Sitka. Smaller and darker specimens grade into the var. *neoniger* Emery.

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AT HARVARD COLLEGE.
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NEW SPIDERS OF THE FAMILY AVICULARIIDAE.

By Ralph V. Chamberlin.

With Five Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
April, 1917.

No. 3.— *New Spiders of the Family Aviculariidae.*

By Ralph V. Chamberlin.

The new genera and species described in the present paper were brought to light in studying the unworked collection of Aviculariidae that has been accumulating for many years in the Museum of Comparative Zoölogy; all the types and paratypes are in the collection of the Museum.

PYCNOTHELINAE, subfam. nov.

Eyes elevated on a distinct tubercle, in a single group; anterior median eyes much the largest.

Labium immovably fused with the sternum; spinules at apex few (or none).

Coxae of palpi long, not at all produced into an apophysis at the distal end; spinules present in an area at proximal end (or absent).

Chelicerae without rastellum.

Tarsi of legs with no unguiculi fasciculares; no inferior claw present; paired claws bearing each a double row of teeth.

No stridulating apparatus present.

Superior spinnerets short, contiguous or subcontiguous; distal article much shortest, nearly as broad as long, rounded. Inferior spinnerets small, contiguous or subcontiguous.

So far as known, tibia I in the male is without spur.

This subfamily has similarities to the Diplurinae, but differs conspicuously in having the labium immovably fused to the sternum and in the short contiguous superior spinnerets. In addition to the new Brazilian genus Pycnothele, described below, I think Lycinus of Thorell, described from Argentine, belongs here rather than in the Diplurinae where placed by its author, though the original description contains no statement as to the condition of the labium. The account of the spinnerets would indicate their agreement with those of Pycnothele. The very large anterior median eyes are a conspicuous character in both genera, which may be separated as follows: —

Anterior median eyes close together, less than their radius apart; spinules present in a group at proximal end of coxae of pedipalps and at least a few on labium; metatarsi I and II scopulate nearly to base.................................Pycnothele, gen. nov.

Anterior median eyes widely separated, their diameter or more apart; no spinules present on coxae of pedipalps or labium; metatarsi I and II scopulate only at distal ends......Lycinus Thorell.

PYCNOTHELE,[1] gen. nov.

Cephalothorax rather long, ovate; pars cephalica low, only moderately convex. Fovea thoracica transverse or slightly procurved.

Eye-tubercle prominent, convex. Anterior row of eyes strongly procurved, the eyes close together, clearly less than radius apart; median eyes very large, much exceeding the others, very close together and even nearer to the lateral ones. Posterior row of eyes straight or recurved; posterior lateral eyes not much removed from the anterior lateral eyes; posterior median eyes much the smallest.

Labium immovably fused with the sternum, a shallow transverse furrow at base; distally truncate; spinules across tip few.

Coxae of pedipalps long, not at all produced into an apophysis at distal end. Bearing a small patch of spinules at proximal end.

Tarsi of legs with no inferior claw; superior claws each with a double row of teeth. All tarsi scopulate to base. Metatarsi I and II scopulate to base or nearly so; metatarsi III and IV not at all scopulate. All legs strongly spined.

The anterior spinnerets are short, clavate, and contiguous. The posterior or superior spinnerets are short, not more than one third the length of the abdomen; the second article is shorter than the first, and the third is much shorter than the second, nearly as wide as long, and rounded.

In the male the tibia of leg I is without trace of spurs at distal end; metatarsus I cyclindrical, slender and straight.

Type Species.— Pycnothele perditus, sp. nov.

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[1] πυκνός, close, compact, θηλή, nipple (spinneret).

PYCNOTHELE PERDITUS,[1] sp. nov.

Plate 1, fig. 1–4.

Type.— M. C. Z. 1. ♂. Brazil: Mendez, Rio Parahyba. Nathaniel Thayer Exped.

Paratype.— M. C. Z. 2. ♀. Brazil: Mendez, Rio Parahyba. Nathaniel Thayer Exped.

Integument of carapace, thorax, legs, palpi, and chelicerae chestnut, sometimes in part dusky. Pubescence of these parts brown of a bronze or copper lustre. Bristles of the legs short, obliquely inserted, dark brown in color. Abdomen with a thick velvety coat of brown pubescence; the bristles moderate or short in length, numerous, reddish brown of a somewhat copper cast.

Eye-tubercle broad; rather abruptly and considerably elevated. Eye-area nearly twice as wide as long (40:21). In the male the anterior row of eyes in dorsal view strongly procurved, a line passing through middles of median eyes running caudad of posterior edges of the lateral ones. Anterior median eyes very large, their diameter exceeding the long diameter of the lateral eyes in about the ratio 8:5; near one fourth their diameter apart and even closer to the lateral eyes. Posterior lateral eyes equal in size to the anterior laterals from which they are separated by about their radius. Posterior median eyes much smaller than the laterals, their long diameter being about three fifths that of the latter; about equidistant from the lateral and the anterior median eyes. A line tangent to the caudal margins of the two posterior eyes on each side runs almost directly transverse.

In what is identified as the female of this species the eyes are less close together and the anterior median eyes are relatively somewhat smaller. Anterior row with procurvature from above as in the male. Anterior median eyes with diameter exceeding that of laterals in only ratio 9:7; one third their diameter or slightly more apart, and one fourth their diameter from the laterals. Relations of eyes otherwise as in the male.

Labium broad; cuspules in a line across anterior end, few.

Cuspules or spinules on proximal end of coxae of pedipalps not numerous and the area covered by them small.

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[1] *perditus*, lost.

The legs of the female conspicuously stouter than those of the male, with legs I and II stouter than III and IV, femur II being thickest.

Metatarsus I and II scopulate to base or nearly so; metatarsi III and IV not at all scopulate. Spines of legs numerous, those of metatarsi and tibiae III and IV especially being conspicuously numerous and stout. In the male metatarsus I is abruptly more slender than the tibia.

In the palpus of the male the tibia is short, narrowed distad. Bulb comparatively large; the spine very short, about one third as long as bulb, straight and needle-like; a thin keel-like plate arising on its ectal side at base and extending proximad as a wing upon the adjacent portion of bulb, and a similar wing on the corresponding caudal surface with several lower edges or keels between and parallel with these two larger ones.

Male (type). Total length cir. 29 mm.

Cephalothorax: length, 14.5 mm.; width, 12.2 mm.; length of pars cephalica 9.1 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	12.2 mm.	16.8 mm.	11.1 mm.	5.8 mm.	45.9 mm.
Leg II	11.1	15.2	10.3	5.8	42.4
Leg III	11	14	12.1	5.2	42.3
Leg IV	14	18.2	17.8	6	56

Length of tibia I, 9.5 mm.; of tibia IV, 12 mm.

Female. Cephalothorax: length, 17 mm.; width, 13 mm.; length of pars cephalica, 10.7 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	11 mm.	15 mm.	7.2 mm.	4 mm.	37.2 mm.
Leg II	10	13.2	7.1	4	34.3
Leg III	9.8	12.1	9	4	34.9
Leg IV	12	16.2	14	5	47.2

Length of tibia I, 7.8 mm.; of tibia IV, 9.5 mm.

ACTINOPODINAE.

ACTINOPUS XENUS[1] sp. nov.

Plate 1, fig. 5.

Type.— M. C. Z. 3. ♀. South America?

Paratypes.— M. C. Z. 4. Three ♀♀. South America?

Integument of carapace and femora of legs dark shining chestnut, the chelicerae darker. The legs distad of the femora may be uniform in color with these or more or less abruptly lighter, more testaceous. Sternum and coxae of legs beneath more brown, of less reddish cast; the labium and coxae of pedipalps darker. Abdomen dark brown.

Pars cephalica anteriorly broad and convex; strongly narrowing caudad, the limiting furrows distinct. Fovea thoracica less than one third the width of the carapace. Pars thoracica depressed; a little in front of each caudolateral corner is a very deep and sharply defined depression which is typically elongate as a furrow subparallel with the caudal margin; a shallower continuation of the mesal end of the furrow sometimes bending cephalad and uniting with a median longitudinal depression of varying depth, this being contiguous anteriorly with the fovea thoracica.

Anterior row of eyes distinctly longer than the posterior. Anterior median eyes their diameter apart; three and a fourth times their diameter from the laterals. Anterior lateral eyes with diameter between 1.2 times that of the medians; twice their diameter from posterior laterals and 1.66 times their diameter from anterior margin of clypeus. Posterior median eyes with long diameter about .9 that of the anterior medians, smaller than that of the posterior laterals in ratio 6:7; only about .55 their diameter from laterals.

Sternum longer than wide (10:9). Anterior median depression distinct, with a weaker second depression caudad of it, or the two depressions continuous and deep. The usual three pairs of foveae converging to the depressed median area caudad of the primary anterior median depression. Hairs rather numerous on borders and anteriorly toward and over the labium.

Labium a little longer than wide; conspicuously narrowed distad; distally with numerous cuspules as usual.

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[1] ξένος, strange, foreign.

Coxae of pedipalps with numerous cuspules along the inner or anteromesal side as usual.

Posterior claw of all legs armed with a tooth at base, but that on claw of leg IV sometimes almost obliterated, that on other legs moderately large. Anterior claw unarmed or with a very small tooth near base. Leg I with 7 or 8 spines on anterior side of tibia and a band of numerous, mostly larger, spines on the posterior side, no spines on ventral surface of this joint; tarsus and metatarsus armed as usual. Leg II with tibia unarmed on the anterior side or ventrally, but with numerous short spines over entire posterior side as usual; metatarsus and tarsus as usual. Leg III with patella bearing 8 stout tooth-like spines in a series along distal margin dorsocaudally and a few proximad of this series, and on the anterior side a similar series also of about eight spines with proximad of it a rather irregular patch of about as many more; tibia with a similar series of spines on the distal margin on the caudal side, while on the anterior side the spines are more numerous than on the patella and the spinous area extends from the distal end proximad of middle of length; metatarsus dorsally with a longitudinal series of spines toward anterior side and with two or three series on the caudal side, some of the latter being strictly lateral, ventrally unarmed excepting for the pair of spines at distal end; tarsus with many spines over lateral surface and also ventrally; patella of third legs much longer than the tibia and the tibia wider than long. Leg IV with patella bearing many spines on anterior side over entire length, but with none at all on posterior side; tibia wholly unarmed; metatarsus unarmed ventrally excepting at distal end, on anterior side with about 8 spines in an irregularly double series extending from a point part way between base and middle to the distal end; tarsus with many spines beneath and especially on the anterior side.

Female (type). Total length; cir. 22 mm.

Cephalothorax: length, 9.8 mm.; width, 9.2 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	6 mm.	6.6 mm.	3.6 mm.	2.2 mm.	18.4 mm.
Leg II	5.9	6	3.5	2.2	17.6
Leg III	5.2	6	3.9	2	17.1
Leg IV	7	8.2	4.9	2	22.1

This species agrees with *A. caraiba* Simon in having the first row of eyes longer than the second, but the difference is more decided; from the latter species it also differs in having the posterior median eyes proportionately larger and less than their diameter from the laterals; and in having the claws of all the legs armed with a subbasal tooth. From *A. scalops* Simon, with which it has points of similarity, it differs in the inequality of the eye-rows above mentioned.

ACTINOPUS PRINCEPS,[1] sp. nov.

Type.— M. C. Z. 5. ♀. Brazil: Rio de Janeiro; Rio de Janeiro. Nathaniel Thayer Exped.

Carapace dark chestnut or somewhat reddish chocolate-color. Chelicerae nearly black, with fringe of bristles red as usual. Legs dark chestnut. Sternum and coxae of legs beneath a lighter chestnut. Labium and coxae of palps darker than the sternum. Abdomen brown, somewhat paler beneath.

Fovea thoracica deep, lunate, clearly more than one third the width of the carapace. A pit-like impression on each side just in front of the caudal margin.

Anterior median eyes less than their diameter apart (about five sixths), and near two and one fourth times their diameter from the laterals and about one and two thirds their diameter from the posterior medians. Anterior lateral eyes with long diameter twice that of the medians, and one and a half times that of the posterior laterals. Posterior median eyes with longitudinal diameter two thirds as large as that of the laterals from which they are separated by a little more than their radius. Anterior row of eyes a little longer than the posterior (38:35).

Sternum widest behind and narrowed cephalad as usual; equal in length and breadth. Anterior median fovea very deep and sharply depressed, widening cephalad. Paired foveae all elongate, their mesal ends narrowing and converging to the caudal end of median fovea where they meet; first pair on level with caudal end of median fovea.

Labium long, with the sides converging distad; anterior margin convex, semicircular. Distal end bearing numerous stout spinules or cusps in transverse rows.

Coxae of palps bearing numerous cuspules similar to those of labium in a broad band across the distal end, none present proximally. Palpi with many stout, curving spines arranged on sides toward ventral surface in mostly two series on tibia, patella, and tarsus. Femur bearing stout bristles but with no true spines. Tarsal claws with two very small teeth proximally.

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[1] *princeps*, first in rank, prince.

Leg I with paired claws each bearing a single long tooth at base; tarsus and metatarsus with the usual band of stout spines on each side; tibia with a similar band of short and some longer spines on the caudal side, while on the anterior side there are only two short spines at the distal end; patella unarmed. Leg II with claws and tarsus and metatarsus similarly armed to those of leg I, with addition of some longer ventral spines; tibia with a dense area of short, acute appressed spinules or teeth on the posterior side, these being much more numerous and densely arranged than on tibia I; patella unarmed. Leg III with claws, tarsus, and metatarsus as in I and II, the metatarsus with spines dense on caudal side but absent on the anterior excepting for a single long terminal one; tibia with many stout short spines on dorsal surface on the distal half; patella with fewer spines or teeth at distal end, these chiefly in two transverse rows. Leg IV having tarsus with few longer spines chiefly on the anterior side; metatarsus with four pairs or ventral spines; tibia unarmed; patella with numerous stout, short spines or teeth in a broad band dorsally along the anterior side; the tooth at base of claw in leg IV and III much reduced.

Female (type). Length 16 mm.

Cephalothorax: length, 7.3 mm.; width, 7.3 mm.

	fem.	tib+pat.	met.	tar.	total
Leg I	4.2 mm.	5 mm.	2.8 mm.	1.6 mm.	13.6 mm.
Leg II	4.2	5	2.8	1.6	13.6
Leg III	4	4.5	3.1	1.5	13.1
Leg IV	5.1	7	3.5	1.6	17.2

This species seems to be close to *A. crassipes* Keys, but it differs importantly from that species according to the description, *e. g.* in the proportions of the cephalothorax and conspicuously in the relative sizes and distances of the eyes. It is like the preceding species and *A. caraiba* in having the anterior row of eyes longer than the posterior.

CTENIZINAE.

Pachylomerus tuobitus[1] sp. nov.

Plate 1, fig. 6–8.

Type.— M. C. Z. 7. ♂. Illinois. Peabody acad. sci. Salem.

Carapace and chelicerae very dark, black or nearly so. Sternum and coxae of legs beneath dark brown or chocolate colored. Legs dorsally almost black, ventrally lighter, more brownish, especially the metatarsi and tarsi as also the tibia of palpus.

Fovea thoracica less than one third the width of the carapace; a single fine impressed line extending from the fovea to the eye-area. Entire surface of carapace densely finely roughened with impressed lines and dots, finely coriaceous.

Anterior row of eyes procurved; median eyes subequal to the lateral, or a little smaller and rather closer to each other than to these. Posterior row of eyes a little recurved; median eyes smaller than the lateral, much closer to the latter than to the anterior median.

Labium bearing on the anterior border 11 cuspules of which 6 are arranged in a distal transverse row in two groups of three each, these being separated by a wide space at middle; the other 5 are arranged somewhat in the form of a V with the apex toward the median interval in the first row.

Metatarsus and tarsus of leg I with a band of spinules along mesolateral surface on each side of scopula; a similar band in corresponding position on the tibia with a few also on the ventral surface; a complete row on the tibia in the type consists of 11 or 12 spinules.

Tibia of male palpus thickest dorsoventrally at middle of length from where it narrows distad and proximad, not at all swollen at base; a fringe of long hairs over its ventral surface. Bulb of the palpal organ globose. Stylus long and distally very slender, distad of the middle evenly curving.

Male (type). Total length, 20 mm.

Cephalothorax: length, 8.2 mm.; width the same, or scarcely narrower.

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[1] Gosiute *tuobit*, black.

	fem.	tib. + pat.	met.	tar.	total
Leg I	7.1 mm.	8.8 mm.	3.3 mm.	2.1 mm.	21.3mm.
Leg II	6	8	3.2	2.2	19.4
Leg III	6	7	3.2	3	19.2
Leg IV	7.5	8.7	5.1	3.1	24.4

Apparently nearest to *P. modestus* Banks, described from New Mexico; but it is a much larger species differing as well in the characters of the eyes (*e. g.* the posterior row recurved instead of procurved), in proportions and structure of the male palpus, in the more numerous spines on tibia of leg I, etc. The two species are alike in their dark color and in the characteristic roughening of carapace and of dorsum of abdomen.

LECHRICTENUS,[1] gen. nov.

Eye-area wider than long, more than 1.5 times so. Anterior row of eyes strongly procurved; median and lateral eyes subequal. Posterior median eyes somewhat larger than the laterals.

Rastellum extending as a narrow band wholly across chelicera; not at all extending proximad along mesal edge; chelicera not in the least prominent at distal end within.

Labium attenuated distad; armed distally with spinules arranged in several series.

Spinules on coxae of maxillipedes confined to an area on proximal half.

Sternal foveolae not far apart; (in type there is in addition a deep transverse furrow tangent to anterior edges of foveolae).

Tibiae, metatarsi, and tarsi of four anterior legs and tarsi and tibiae of palpi with a longitudinal band of spinules on each side. Metatarsus and tibia of leg III spinulose above at distal end only. Tarsi of legs III and IV pluriaculeate near claws.

Type Species.— Lechrictenus lamprus, sp. nov.

This genus differs from Pachylomerus, which it in general resembles, in having (1) the anterior median eyes subequal to the laterals as in Conothele; (2) the metatarsus III aculeate only at distal end, also much as in the latter genus; (3) the spinules on coxae of pedipalps confined to proximal half; and (4) conspicuously in the form of the rastellum. The eye-area is narrower proportionately than in the Asiatic genus Conothele, the anterior row is more strongly procurved, the posterior median eyes are relatively larger, etc.

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[1] λέχριος, slanting, oblique, κτείς, a comb.

Lechrictenus lamprus,[1] sp. nov.

Plate 1, fig. 9, 10; Plate 2, fig. 1.

Type.— M. C. Z. 8. ♀. Florida?

Carapace and sternum shining chestnut; legs similar; the distal articles darkest, in part mahogany or black, the femora paler ventrally. Chelicerae black, the hairs of the oral fringe and that in a transverse band above the rastellum rufous. Abdomen fuscous.

Pars cephalica strongly elevated, highest midway between eyes and fovea thoracica immediately in front of the posterior declivity; anterior border elevated, there being a pronounced transverse furrow on a level immediately caudad of eye-area. Fovea thoracica strongly lunate; less than one third the width of the carapace.

Eye-area between 1.5 and 1.7 times wider than long. Anterior row of eyes strongly procurved; eyes equal or very nearly so. Posterior row straight or slightly recurved shorter than the anterior row: the median eyes larger than the lateral ones.

Sternum distinctly longer than wide. Relatively broader caudally and more strongly narrowed cephalad than, *e. g.*, in *Pachylomerus audouini*. A conspicuous transverse furrow tangent to anterior edges of foveolae, the furrow extending nearly half way from median line to margin on each side. Foveolae not far apart.

Labium broad at base but strongly narrowed and rounded distad. Spinules at distal end in three transverse series, these in the type 8 in number (3, 3, 2).

Spinules on the coxae of the pedipalps in a subtriangular patch with apex distad toward middle of article, none occurring on distal portion.

Rastellum composed of numerous stout teeth arranged in a transverse band across entire width of chelicera above base of claw, but not at all extending proximad along the inner edge as it does, *e. g.* in species of Pachylomerus and with no trace of a rounded lobe or process at distal end on inner side of claw.

Spinules of lateral bands of tibiae, metatarsi, and tarsi of legs I and II dense and short. Metatarsus of leg III dorsally with a band of short spinules across distal end, the dorsal surface elsewhere free of spines but a few on anterior and posterior surface in a single series extending proximad to middle. Tibia III with numerous similar short spinules at distal end above. Many spines near claws on tarsi III and IV.

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[1] λάμπρος, distinct, manifest.

Female (type). Total length about 26 mm.

Cephalothorax: length, 13.7 mm.; width, 12 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	7.2 mm.	9.25 mm.	3.2 mm.	2.1 mm.	21.75 mm.
Leg II	6.9	8.2	3	2.1	20.2
Leg III	6.8	7.8	3.1	3.1	20.8
Leg IV	8.5	9.25	5.2	3.1	25.55

APTOSTICHUS SIMUS,[1] sp. nov.

Plate **2**, fig. 2, 3.

Type.— M. C. Z. 9. ♀. California: San Diego. G. R. Crotch.

Pars cephalica conspicuously elevated. Fovea thoracica nearly transverse, being but slightly procurved.

Ocular tubercle much lower than in *A. atomarius* Simon. Anterior row of eyes strongly procurved; median about half the diameter of the lateral. Posterior median eyes a little smaller than the anterior median and much smaller than the posterior laterals.

Posterior sternal impressions proper small, oval, widely separated from each other and also from the margin but each with a shallow depression or furrow continuing from its ectal end to the margin.

No spinules present on labium in the type.

Spinules of coxae of pedipalps in a dense area sharply limited and confined to mesocaudal corner.

Tarsus of palpus scopulate beneath, the scopula divided by a distinct band of short setae; tibia with 3 very long spines in a series on mesal side below, the most proximal of these spines being almost bristle-like.

Tarsi and metatarsi of legs I and II scopulate to base, the scopula divided by a distinct setose band. Metatarsus and tibia of leg I wholly lacking spines in the type. Tibia of leg II with a series of 3 very long spines on ventral surface toward ectal side, but with no apical spines; metatarsus with two pairs of ventral spines proximad of middle, with three apical spines and immediately proximad of these 3 additional very small spines or spine-like bristles. Patella of leg III with about 15 curved, appressed spines on the anterior side arranged in 3 longitudinal series; tibia as usual with a band of spines on each side but with none strictly dorsal in position. Tibia of leg IV unarmed excepting for two slender apical spines beneath; tarsus with two pairs of spines on anterior side toward distal end and on inner side with two spines also toward distal end. Claws of posterior legs with 5 teeth in a single sinuous series, the next to the most proximal of these being much the longest. The teeth on claws of anterior legs are similar, or only 4 may be present on claws of leg I; the teeth are similarly in a single series but this is more strongly sinuous and may appear double.

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[1] Gosiute *sima*, one, single.

Female (type). Length 12 mm.

Cephalothorax: length, 6 mm.; width, 5 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	4.3 mm.	5.1 mm.	2.2 mm.	1.1 mm.	12.7 mm.
Leg II	3.8	4	1.8	1.3	10.9
Leg III	3.4	3.2	2	1.5	10.1
Leg IV	4	5.1	3.1	1.8	14.

Readily distinguished from the other species known by differences in spining of the legs (*e. g.*, in wholly lacking spines on tibia and metatarsus of leg I).

AVICULARIINAE.

Cyrtopholis medius, sp. nov.

Plate **2**, fig. 4–6.

Type.— M. C. Z. 17. ♂. W. I.: St. Kitts, F. Lagois.

Paratype.— M. C. Z. 17. ♂. W. I.: St. Kitts, F. Lagois. March, 1879.

Paratype.— M. C. Z. 18. ♀. W. I.: St. Kitts, F. Lagois.

Integument of cephalothorax, legs, and chelicerae chestnut. Pubescence of these parts brown of a golden lustre and cinereous intermixed, the latter being especially conspicuous on ventral surface of femora. Bristles either wholly brown or with distal portion grey; bristles of legs more than usually numerous. Legs showing the usual somewhat lighter longitudinal streaks above but otherwise unmarked. Abdomen with the large black spot above as in *C. bartholomei*, etc.

Anterior row of eyes procurved; a line tangent to anterior margins of median eyes in dorsal view passing a little in front of middle of lateral eyes. Anterior median eyes with diameter equal to long diameter of the lateral eyes; only their radius apart and distinctly closer to the lateral eyes. Posterior lateral eyes with longitudinal diameter three fourths that of the anterior laterals; clearly larger than the posterior medians.

Cuspules of labium and of coxae of palpi as usual.

Tibia of palpus of male slender; without spines. Bulb of palpal organ mostly red in color; pyriform, the bulb gradually narrowing into the spine which becomes distally slender and acute; spine somewhat flattened, slightly twisted, its anterior surface concave and its caudal convex, not carinate.

Stridulating organ consisting of 20–24 clavate and plumose bristles on trochanter I and of about 24 similar ones on the trochanter of the palpus.

Metatarsus III scopulate over distal two thirds of length; metatarsus IV scopulate only at distal end. Scopula of tarsus IV alone divided by setose band, that of tarsus III being entire.

First leg of male with the tibia clearly longer than the metatarsus; inferior spur slender, curved mesad and dorsad, apically somewhat rounded but produced into an acute spinous point toward dorsal edge. Superior process or spur rather more than half as long as the inferior one, expanding weakly at distal end and bearing on the edge toward the inferior process a stout closely appressed spine. Metatarsus gently bowed dorsad as in various related species.

Femur of leg III considerably swollen but less so than in *C. femoralis*, the ratio of width to length above being 3.1: 9 as against 3: 7.8.

Male (type). Cephalothorax: length, 11.3 mm.; width, 9.2 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	10.7 mm.	14.1 mm.	8 mm.	4.6 mm.	37.4 mm.
Leg II	9.8	12.5	8.1	4.5	34.9
Leg III	9	11	9	5	34
Leg IV	10.8	14.1	12.1	5.2	42.2

Resembling the form identified by Pocock as *C. bartholomei* Latr. in general structure but a clearly smaller species, differing also in the closer approximation of the eyes of the anterior row, somewhat in the form of the palpal organ, the form of the processes of tibia I in the male, the greater relative length of tibia I to metatarsus I, etc. It seems also to be especially close to *C. femoralis* Pocock, described from Montserrat; but it differs in having metatarsus I in the male bowed dorsad instead of straight, in the less crassate femur of leg III, and in having the scopula of tarsus III entire; the posterior lateral eyes are relatively larger.

CYRTOPHOLIS PORTORICAE, sp. nov.

Plate 2, fig. 7.

Type.— M. C. Z. 16. ♀. Porto Rico.

Integument of cephalothorax and appendages chestnut. Pubescence of carapace brown, with some of cinereous color intermixed especially along the edges. The grey and brown hair intermixed on legs as usual with the grey most abundant on ventral surface of femora and coxae as well as much on sternum. The usual lighter stripes above on legs showing especially on patellae and tibiae. Abdomen with the large black spot on caudal half above as in related species. Bristles of legs fewer and shorter than in the preceding species; brown, in part paler distally; those of abdomen fewer and less conspicuous than in *C. medius.*

Anterior row of eyes procurved in such degree that a line tangent to anterior margins of the median eyes in dorsal view passes through anterior third of lateral eyes. Anterior median eyes equal in diameter to the longitudinal diameter of the laterals or slightly larger; their radius or a little more apart. Posterior lateral eyes with longitudinal diameter about two thirds that of the anterior laterals, more than their radius from the latter. Anterior eyes with visual axis directed less laterad than in *C. medius.*

Cephalothorax relatively narrower than in *C. medius.*

Palpus when extended along side of leg I reaching to the end of proximal third of metatarsus of the latter.

Stridulating bristles of trochanter of palpus slender, acute, only slightly clavate, near 30 in number; those on trochanter I 30 or more, closely arranged, shaped like those of palpus.

Female (type). Total length near 23 mm.

Cephalothorax: length, 10.2 mm.; width, 8 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	7.9 mm.	10.4 mm.	5 mm.	3 mm.	26.3 mm.
Leg II	6.3	9	5	3	23.3
Leg III	6	7.7	5.1	3.1	21.9
Leg IV	8.1	10.4	8	4	28.5

Differs from *C. medius*, above described, in having the plumose bristles of the stridulating organ decidedly more slender and less clavate and also more numerous. Bristles of legs and abdomen less coarse, fewer in number and shorter. Anterior row of eyes less procurved.

CYRTOPHOLIS ANNECTANS, sp. nov.

Plate 3, fig. 1, 2.

Type.— M. C. Z. 23. ♂. W. I.: Barbados, 1870. J. Graham Briggs.

Paratype.— M. C. Z. 24. ♀. W. I.: Barbados, 1870. J. Graham Briggs.

Integument of carapace, sternum, legs, and chelicerae when dry black or nearly so, showing in parts a faint reddish tinge which is more evident when specimens are immersed. Pubescence of cephalothorax and appendages golden brown. On the legs the usual longitudinal streaks of grey show above, especially on patellae and tibiae, and across distal ends of joints is the narrow line of similar grey hair. Bristles of legs of a more reddish cast proximally, distally becoming greyish.

Anterior row of eyes in dorsal view weakly procurved, a line tangent to anterior edges of median eyes passing in front of middle of lateral eyes. Anterior median eyes about equal to or scarcely larger than the laterals as measured by long diameter; about their radius apart and a little farther from the laterals. Posterior lateral eyes nearly equalling the anterior laterals from which separated by a little less than three fourths their diameter. Posterior median eyes very much closer to the lateral eyes than to the anterior median eyes; clearly smaller than the laterals; moderately elliptic. A line tangent to the caudal edges of the two posterior eyes of each side touching or passing very close to the anterior median eye of the opposite side. Eye-area wider than long in ratio 48: 25.

Stridulating bristles on trochanter I numerous, 30 or more in number scarcely or not at all clavate from above base to middle, distally acuminate; plumose, much larger than in *C. medius*. No plumose hairs on femur I.

In the male palpus the tibia is not enlarged; narrowing distad as usual. Process of bulb compressed laterally though narrow, attenuated toward tip and acutely pointed; in anterior view curving ectad distally, the curve even, the process not geniculate.

Scopula of tarsus IV in the male with a row of a few setae along median line, but these only vaguely dividing the scopula, while in the female no setose line at all is detectable, the condition there being that of the Eurypelmateae; in this respect the species agrees with *C. bonhotei* Cambridge described from the Bahamas and by its author made the type of Lyroscelus.

Tibia I in the male with the inferior spur slender, narrowed, and conspicuously curving mesad at distal end. Superior process short, bent toward the inferior process, expanded at end into a small subcircular plate-like form. Metatarsus a little bent dorsad near level touched by the inferior process of tibia when the joint is flexed.

Male (type). Length 37 mm.

Cephalothorax: length, 17 mm.; width, 14 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	14 mm.	18.2 mm.	10.7 mm.	6.1 mm.	49 mm.
Leg II	13	16.2	11.1	6.1	46.4
Leg III	12	15.3	12	6	43.3
Leg IV	14.5	18	16	7	55.5

Female. Cephalothorax: length, 19.7; width, 17 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	14 mm.	17.6 mm.	8.1 mm.	5.8 mm.	45.5 mm.
Leg II	12	15.1	9	5.8	41.9
Leg III	11.3	14	10	5.8	41.1
Leg IV	14	17.1	14	6	51.1

This is a larger species than *C. medius* and differs as well from that form in proportions; *e. g.* tib.+ pat. I is a little longer than tib.+ pat. IV in both sexes, and metatarsus IV in the male is shorter than the cephalothorax whereas in *C. medius* it is decidedly longer while a very characteristic feature is the essentially entire condition of the scopula of tarsus IV; the process of the palpal organ is very nearly the same but it is proportionately more slender; tibia I is equal to metatarsus I whereas in *C. medius* it is longer. It is undoubtedly close to the form identified by Pocock as *C. venatorius* Linné (= *bartholomei* Latr.); but I am unable to satisfy myself from the descriptions as to the identity of the species had by Linné or Latreille since there now appear to be a number of closely related species on the Antilles agreeing equally well with the original accounts.

CYRTOPHOLIS PELUS,[1] sp. nov.

Plate 2, fig. 8–10.

Type.— M. C. Z. 20. ♂. W. I.: St. Thomas. Hassler Exped.

Paratype.— M. C. Z. 21. ♂. W. I.: St. Thomas. Hassler Exped.

Paratypes.— M. C. Z. 22. Two ♀♀. W. I.: St. Thomas. Hassler Exped.

The integument of the cephalothorax and appendages is blackish as in the preceding species. The pubescence on the carapace is a much darker brown than in that species but has similarly a distinctly golden lustre. The pubescence of the legs above in general is very dark so that the longitudinal grey stripes appear very sharply defined and conspicuous in consequence; legs paler beneath and with the usual grey fringe across ends of joints above; bristles short, numerous, dark reddish brown. Abdomen with the velvety black spot above as in the related species.

Eye-tubercle sharply limited and strongly elevated, convex. Eye-area wider than long in ratio 21:10. A line tangent to the anterior margins of the anterior median eyes passes through the anterior third of the lateral eyes. Anterior median eyes with diameter a little larger than the long diameter of the laterals (ratio 14:13); their radius or less apart and nearly as close to the laterals. Posterior lateral eyes much smaller than the anterior laterals (ratio of long diameters about 2:5), from which they are separated by their own diameter. Posterior median eyes fully as large as the laterals. A line tangent to the caudal edges of the two posterior eyes on each side touching or intersecting the anterior median eye of the opposite side.

Stridulating spines of trochanter I numerous and densely arranged; clearly more numerous than in *C. annectans* and also much more slender and acute than in that species; gradually acuminate, not at all clavate (Plate **2**, fig. 9).

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[1] πελός, dark colored.

Scopula of tarsus IV with setose line detectable proximally only, the setae few, much as in the preceding species and *C. bonhotei* Cambr.

Metatarsus I in the male only slightly bowed dorsad, the curve mostly a little distad of point touched by inferior tibial spur when joint is flexed. Inferior tibial spur slender, curved dorsomesad and somewhat narrowed distad. Superior spine shorter than in *C. annectans* and straight; not expanded distad but bearing on inferior edge the usual stout and closely appressed spine.

Femur III in the male but little thickened, being 3.33 times longer than wide.

Palpus of the male with tibia not enlarged, narrowed distad. Spine of bulb slender, terete, and needle-like distally; bent first a little forward and then more considerably ectad.

Male (type). Length 32 mm.

Cephalothorax: length, 16.8 mm.; width, 13.6 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	14.8 mm.	19 mm.	12 mm.	6.5 mm.	52.3 mm.
Leg II	13.7	16.7	12	6.2	48.6
Leg III	11.8	15	12	6	44.8
Leg IV	14.2	17.8	16	6.1	54.1

Metatarsus I equal to or a little exceeding tibia one above.

Clearly separated from *C. annectans* in the character of the palpal organ, the spine being very slender and needle-like instead of compressed. The pubescence is conspicuously darker and the posterior eyes are very different in their relative sizes. It seems to be near to *C. bonhotei* Cambr., from the Bahamas, which it resembles in the form of the stylus of the palpal organ, but this is longer and more curved; the stridulating spines of trochanter I are much more numerous and less clavate and are inserted over the entire length of the article; and tib. + pat. I is longer than tib. + pat. IV.

CALOPELMA,[1] gen. nov.

Ocular tubercle moderately high. Anterior median eyes a little larger than the laterals to which they are clearly closer than to each other.

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[1] καλός, pretty, πέλμα, sole of the foot.

Labium minutely densely spinulose at distal end.

Fovea thoracica transverse or pit-like.

Metatarsus I scopulate nearly to base; metatarsus II scopulate to or a little proximad of middle; metatarsi III and IV scopulate only at distal end. Scopula of tarsus III with setose line only at base; that of tarsus IV divided by a narrow median line of setae over whole length. Metatarsus I armed at base as well as at apex, with a spine. Metatarsus II ventrally with an apical spine and proximad of middle with three, 2 in a longitudinal series with 1 mesad of the more basal of these; a single spine in addition on mesal side.

In the male metatarsus I is bowed dorsad. Tibia I with two spurs at distal end of which the superior one is much the shorter; the inferior or ectal one curved dorsad, the tibia closing against mesal side of its tip.

Tibia of palpus of male without trace of a rastellum of spines.

Type Species.— Calopelma brasiliana, sp. nov.

In some respects this genus is intermediate between Hapalopus and Hemiercus as defined by Simon. It differs from both in lacking a rastellum on the tibia of the male palpus, in having the fovea thoracica transverse instead of procurved, and in the different spining of metatarsus I. From Hapalopus it also differs in the inequality of the eyes of the anterior row, in having the spurs of tibia I in the male very unequal in length, etc.

CALOPELMA BRASILIANA, sp. nov.

Plate 3, fig. 3, 4.

Type.— M. C. Z. 25. ♂. Brazil: Rio de Janeiro; Rio de Janeiro. Nathaniel Thayer Exped.

Integument of carapace excepting in front of eye-tubercle, and of legs, palpi, and chelicerae very dark chestnut, almost black; that of the sternum, coxae of legs beneath, and coxae of palpi, chestnut. Pubescence of carapace golden brown. Pubescence of legs brown-grey, two longitudinal darker stripes showing especially on tibiae above, with one basally oblique one on metatarsi; bristles light brick-red, of moderate length, more numerous ventrally. Sternum and coxae of legs beneath with pubescence almost wholly grey with longer light brick-red hairs more sparsely scattered. Abdomen above velvety black; a longitudinal area extending caudad three fourths of the length and somewhat constricted near middle with but few bristles, this area being left thus almost clear black, while bordering it and on sides of abdomen long brick-red bristles are densely arranged and conceal the black of the shorter pubescence; similar but shorter brick-red hairs over ventral surface.

Ocular area wider than long in ratio 36: 19; the two eye-rows equal in length. Anterior row of eyes viewed from in front strongly procurved, a line tangent to the lower edges of the medians passing well above the laterals; viewed from above the row is very weakly procurved, a line tangent to anterior edges of the medians passing well in front of the middle of surface of the laterals. Anterior median eyes larger than the laterals in about ratio 13: 11; not quite two thirds their diameter apart and scarcely more than one third their diameter from the laterals. Posterior lateral eyes equal in long diameter to the anterior laterals from which they are separated by a distance equal to their radius. Posterior median eyes with diameter smaller than that of the laterals in ratio 9: 11; but little elongate; closer to laterals then to anterior medians.

Tibia I in male equal to the metatarsus or scarcely exceeding it. Outer or inferior process of tibia curved dorsad and at tip a little mesad, twice as long as the superior spur which bears a stout spine appressed to its ectal edge.

Patellae III and IV unarmed.

Tibia of male palpus unarmed with spines. Stylus of bulb of palpal organ bent at base at right angles to the long axis of the bulb; at base as broad as contiguous part of bulb; compressed, gradually narrowing distad; toward distal end raised into a longitudinal median keel on its ectal surface, the mesal surface being correspondingly grooved; in anterior view the spine distad of the middle bends abruptly ectad and then more ventrad at the very tip which is acute.

Male (type). Length.— 25 mm.

Cephalothorax: length, 11 mm.; width, 10.1 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	12.1 mm.	15.1 mm.	9.6 mm.	5 mm.	41.8 mm.
Leg II	11.2	13.9	8.2	4.4	37.7
Leg III	9.7	12.1	8.8	4.8	35.4
Leg IV	11.8	14.7	12	5.1	43.6

Grammostola chalcothrix,[1] sp. nov.

Plate 3, fig. 5–7.

Type.— M. C. Z. 41. ♂. Argentina: Rosario. W. M. Davis.
Paratype.— M. C. Z. 42. ♂. Argentina: Rosario. W. M. Davis.

Integument of cephalothorax, legs, and palpi excepting the coxae ventrally very dark chestnut; that of chelicerae black. Pubescence of cephalothorax and legs dark brown of bronze or golden lustre; the bristle-free streaks on joints above very inconspicuous, not contrasting in color of pubescence but only through absence of the bristles. Bristles of legs dark brown proximally, lighter distad. Joints of legs with the usual fringe of light hairs across distal ends above; femora greyish ventrally; pubescence of coxae also with much grey ventrally. Abdomen with long bristles dorsally and laterally and shorter ones ventrally of golden yellow color excepting for their darker bases.

Eye-tubercle convex, at middle strongly elevated, vertical in front and steeply slanting behind. Ocular area wider than long in ratio 45: 25; anterior and posterior eye-rows equal or nearly so. Anterior row of eyes as seen from above considerably procurved, a line tangent to anterior edges of the medians passing somewhat caudad of middle of surface of laterals. In anterior view a line tangent to lower edges of medians passes well above lateral eyes. Anterior median eyes with diameter equal to the long diameter of the laterals; their radius or but little more apart and very nearly the same distance from the laterals. Posterior lateral eyes smaller than the anterior laterals their diameters being in ratio of about 5: 6; four fifths their diameter from the anterior laterals. Posterior median eyes with long axis equal to that of the laterals to which they are much nearer than to the anterior medians.

Stridulating spines on coxa I brown, small, slender, distinctly clavate (Plate 3, fig. 6); very numerous, being closely crowded in a large scopula-like area at the distal end above the suture and in a similar area below it. The spines on coxa of palp in a similar large scopuliform patch at distal end.

Metatarsus of leg I in the male curved; scopulate to base or very nearly so; shorter than the tibia. Processes of tibia I divergent; superior one much the shorter, straight, narrowed toward apex, a stout spine springing from base of its ectal edge as usual but this somewhat divergent; inferior process bent dorsad and somewhat mesad at tip. Metatarsus II scopulate nearly to base; metatarsus III scopulate nearly to middle; and metatarsus IV scopulate over distal third.

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[1] χαλκός, bronze, θρίξ, hair.

Spine of the male palpal organ long, very slender and needle-like distally; in lateral view geniculate at beginning of the more slender portion; in anterior view curving conspicuously but nearly evenly ectad.

Male (type). Length cir. 38 mm.

Cephalothorax: length, 19 mm.; width, 16.1 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	16.7 mm.	21.1 mm.	13 mm.	7 mm.	57.8 mm.
Leg II	16	20.1	13	7	56.1
Leg III	14	17.1	13.9	7.5	52.5
Leg IV	16.1	20.3	17	8.2	61.6

This species has similarities to *G. mallicomum* Auss., especially in the stridulating organ. *G. mallicomum* has also been recorded from Argentina. In the present species the male palpal organ is conspicuously different, the stylus being much longer, more slender, and more curved. The eyes of the anterior row are larger and closer together and in the male the elevation of the median ones above the laterals in anterior view is distinctly greater. The eye-tubercle in the female is relatively much lower. Tibia I in the male is longer than the metatarsus. The cephalothorax in the male much exceeds metatarsus IV.

GRAMMOSTOLA CALA,[1] sp. nov.

Plate 3, fig. 8, 9.

Type. M. C. Z. 39. ♂. Chile: Talcahuano. Hassler Exped.

Paratype.— M. C. Z. 40. ♂. Chile: Talcahuano. Hassler Exped.

Integument of carapace, sternum, legs, and chelicerae, excepting sides of coxae and ventral part of chelicerae, black or very nearly so. Pubescence of carapace grey and brown; the longer hairs about margins brown of pink tinge. Legs above with pubescence grey and brown, with longer and stouter dark hairs; femora, patellae, and tibiae showing two conspicuous narrow longitudinal stripes of white or light grey hair unmixed with the brown and a similar median dorsal line on proximal portion of metatarsi; a narrow band of grey hair across distal ends of joints above; femora ventrally with black pubescence intermixed with that of lighter color and on anteroventral surface of femur I predominating; bristles long, numerous, light rust-brown with in part a pinkish tinge, especially distally. Pubescence of sternum and of coxae beneath dense velvety black. Fringe of chelicerae and endites rosy. Pubescence of venter of abdomen velvety black; bristles of dorsum like those of legs.

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[1] καλός, beautiful.

Eye-tubercle moderately elevated, convexly bulging between anterior median eyes. Eye-area wider than long in ratio 41:23. Posterior row a little longer than the anterior (41:39). Anterior row of eyes not strongly procurved, a line tangent to anterior margins of median eyes in dorsal view passing through anterior third of lateral eyes. Anterior median eyes about equal or slightly less in diameter than the lateral eyes; a little less than their diameter apart (20:23), only a little more than their radius from the laterals. Posterior lateral eyes with long diameter larger than that of the anterior laterals (28:25), from which they are removed by about their radius. Posterior median eyes ellipti̧c, very clearly smaller than the lateral eyes, the ratio of long diameters being 9 or 10:14.

Stridulating organ embracing bristles in an area on distal third of coxa of palp, the area broader distad than proximad; bristles clavate, about 30 in number. Stridulating bristles on coxa I forming a patch above suture and a rather smaller one below it; the bristles above suture larger than those below.

Scopula of metatarsus I dense, extending proximad to middle only; that of metatarsus II like that of I; metatarsus III with scopula a little sparser; metatarsus IV with scopula covering only about distal third.

Metatarsus of leg I in the male only weakly bowed. Processes of tibia parallel or but slightly divergent, the superior one decidedly more slender and two thirds as long as the inferior one, with the usual stout spine appressed to the ectal edge; inferior process abruptly bent dorsad toward its distal end, but its tip not reaching projected axis of the other process; inferior process proximad of the abrupt bend straight or nearly so.

Stylus of palpal organ of male long, distally very slender and needle-like; in lateral view only weakly and evenly curved, not at all geniculate; in anterior view moderately bent ectad, the curve chiefly at middle of length.

Male (type). Length 38 mm.

Cephalothorax: length, 19.1 mm.; width, 16.5 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	16.8 mm.	23 mm.	11.3 mm.	7 mm.	58.1 mm.
Leg II	15.1	20	11.3	7	53.4
Leg III	14	16	12	7	49
Leg IV	16	20	15.1	8	59.1

Grammostola spatulatum Cambr., also from Chile and apparently closely related, differs in having the stridulating spines of coxae of palp and leg I few in number and of larger size, red in color; in having the metatarsus I as long as tibia (in *G. cala* shorter in ratio 11:13); in the different form of spine of palpal organ, etc.

EURYPELMA REGINA,[1] sp. nov.

Plate 4, fig. 1.

Type.— M. C. Z. 56. ♂. Brazil: Rio de Janeiro; Rio de Janeiro. Nathaniel Thayer Exped.

Paratypes.— M. C. Z. 57. Two ♀♀. Brazil: Rio de Janeiro; Macacos. William Roberts.

Integument of carapace, sternum, palpi excepting coxae ventrally, chelicerae excepting ventrally, and legs black or in part of dull chestnut-black. Coxae of palps beneath proximal portion of labium, and chelicerae ventrally, lighter and more reddish. Pubescence of these parts in general dark chocolate-brown, with grey intermixed on ventral surface of femora, on lower part of anterior surface of chelicerae, etc. Fringe of the chelicerae and endites bright red as usual. The longitudinal streaks on patellae and other joints, in many species occupied by lighter pubescence, are in the present one glabrous, bristle free, a fringe of hair extending in on each side partly covering integument. Pubescence of sternum and coxae ventrally velvety chocolate-brown, some grey intermixed on the coxae. Bristles of legs long, numerous, rufous proximally and cinereous distally; those of the dorsum of the abdomen similar to those of legs but those of the lower lateral and ventral surfaces rufous throughout.

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[1] *regina*, queen.

Distal ends of endites with cuspules numerous and dense.

Eye-tubercle elevated abruptly; moderately high, convex. Ocular area, in female, twice as wide as long or a little more caudally, the posterior row of eyes being wider than the anterior in the ratio 13: 12. Anterior row of eyes viewed from in front procurved in such degree that a line tangent to the lower edges of the median eyes passes a little above the upper edges of the lateral ones; viewed from above a line tangent to anterior edges of median eyes passes a little in front of middle of surface of each lateral eye. Anterior median eyes with diameter about seven eighths the long diameter of the laterals; three fourths their diameter apart and almost the same distance from the laterals. Posterior lateral eyes with longitudinal diameter exceeding that of the anterior laterals in about ratio 19: 17. Posterior median eyes elongate, the long axis equalling that of the lateral ones or very nearly so; outer edge a little incurved just cephalad of middle; only slightly nearer the lateral eyes than to the anterior medians. A line tangent to caudal edges of two posterior eyes on each side intersecting anterior median eye of the opposite side.

Trochanters of palpi and of leg I with no plumose hairs. Metatarsus I scopulate about three fourths of length toward base, metatarsus II two thirds the length, III from one third to one half, and IV only at the distal end. In the male, metatarsus I has two spines on anterior edge near scopula, one distal and one proximad of middle; two or three ventral spines near middle and one more proximad. Metatarsus II along ventrocaudal surface with an apical, a submedian, and a subbasal pair of long spines; one single spine between middle and distal end at edge of scopula; in anteroventral line a basal spine and one at distal end; a fourth spine at distal end on anterior side and three in line with it more proximad. Femur I with a spine on anterodistal corner above; femur II with 1 to 3 spines in corresponding position; femora III and IV with three or four spines along dorsocaudal edge as well as with two or three along the anterodorsal edge distad of middle of length. All patellae with a spine on anterior side.

Palpus of male with tibia slender, distally narrowed. Bulb of palpal organ black. Stylus compressed throughout length and of uniform width to near tip where acutely pointed; in lateral view abruptly geniculate near middle of length, the two parts being nearly at right angles to each other; in anterior view also strongly bent ectad, but the angle considerably greater than a right angle.

First leg in male with metatarsus moderately bowed in the frequent way, the curvature being chiefly a little proximad of middle; nearly equal in length to the tibia. Processes of tibia divergent; the superior one straight, more than half the length of the inferior one; inferior process curving throughout, with the concavity dorsad as usual.

Male (type). Length 39 mm.

Cephalothorax: length, 20.2 mm.; width, 18.7 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	18 mm.	24 mm.	13.8 mm.	8.2 mm.	64 mm.
Leg II	17	22	15	8.2	62.2
Leg III	16	20	18	8	62
Leg IV	17.6	23.1	23	9	72.2

Female. Length, 50 mm.

Cephalothorax: length, 25.1 mm.; width, 23 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	18.2 mm.	24.8 mm.	11.3 mm.	6.8 mm.	61.1 mm.
Leg II	17	22.2	12.1	7	58.3
Leg III	15.8	20	16.2	7	59
Leg IV	18.8	23	22	8	61.8

Resembling in various ways *E. minax* Thorell, but differing in having metatarsus IV essentially equal to tibia + patella IV in the male; the more abundant spining of metatarsi I and II; and apparently especially in the palpal organ. From *E. doeringi* Holmberg it differs in having the cephalothorax in the male much shorter than the tibia + patella IV instead of longer. It differs from *E. tigrinum* (Pocock), *E. saltator* (Pocock), and *E. vitiosum* Keyserling (genus Pterinopelma of Pocock) in lacking plumose hairs on trochanters of palpus and leg I.

EURYPELMA ABERRANS, sp. nov.

Plate 4, fig. 2.

Type.— M. C. Z. 52. ♀. Chile: Casa Blanca.

Integument of carapace, sternum, palpi, and legs chestnut; chelicerae black or nearly so at base above, but chestnut distally and ventrally. Coxae of palps brighter colored beneath as usual. Body in type almost denuded of hair so that this cannot be properly described; such hair as there is on carapace and legs is rust-brown in color.

Pars cephalica very low; only slightly rising above the level of the pars thoracica.

Ocular tubercle very low. Ocular area very nearly twice as wide as long (48: 25); the two eye-rows equal in length. Anterior row of eyes viewed from in front only moderately procurved, a line tangent to the lower edges of median eyes intersecting the upper part of the laterals; viewed from above a line tangent to the anterior edges of the median eyes passes near middle of surface of each lateral one. Anterior median eyes much smaller than the laterals, the diameters being to each other as 23: 38; more than three fourths their diameter apart and only about half as far from the laterals. Posterior lateral eyes with longitudinal diameter three fourths or a little more that of the anterior laterals, from which they are separated by less than their radius. Posterior median eyes with long diameter about four fifths that of the lateral eyes; scarcely elongate, truncate behind; a little closer to lateral eyes than to anterior medians.

Metatarsi I and II scopulate to base; metatarsus III scopulate to middle; metatarsus IV scopulate only at distal end.

Female (type). Length, 48 mm.

Cephalothorax: length, 20.4 mm.; width, 18 mm.; length of pars cephalica 12.2 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	14.2 mm.	20 mm.	9.1 mm.	6.25 mm.	49.55 mm.
Leg II	13	18	9.1	6.8	46.9
Leg III	12.2	16.1	11	7	46.3
Leg IV	15.5	20	15	8	58.5

Tibia I in length 11 mm.

This appears to be the only true Eurypelma thus far recorded from Chile.

Eurypelma latens,[1] sp. nov.

Plate 3, fig. 10.

Type.— M. C. Z. 47. ♂. Nicaragua: Polvon. John A. McNeil.

Paratypes.— M. C. Z. 51. ♂, ♀. Nicaragua: Polvon. John A. McNeil.

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[1] *lateo*, lurk, hide.

Paratypes.—M. C. Z. 50. Ten immature specimens. Nicaragua: Polvon. John A. McNeil.

Integument of cephalothorax, legs and palpi from light to very dark chestnut; chelicerae darker, in some individuals nearly black above at base, paler beneath as usual. Pubescence of carapace brown of a bronze lustre to more golden brown. Pubescence of legs darker brown; patellae and tibiae dorsally with two longitudinal stripes of bristles free light hair and the metatarsus with a similar single stripe at proximal end; bristles short, from dark reddish brown (male) to light brown (female). The femora with more grey pubescence intermixed ventrally. Pubescence of sternum and coxae of legs beneath brown. Entire dorsum of abdomen black, the sides and venter abruptly paler, brown. Bristles of dorsum of abdomen reddish brown proximad becoming cinereous distad.

Eye-tubercle moderate in height. Ocular area (female) just twice as wide as long; the anterior and posterior rows equal in length. In anterior view a line tangent to lower edges of anterior median eyes passes but slightly above the lateral eyes; in dorsal view a line tangent to anterior edges of median eyes passes near or a little in front of middle of surface of each lateral eye. Anterior median eyes with diameter less than the longitudinal diameter of the laterals in ratio 5: 7; four fifths their diameter apart and about their radius from the lateral eyes. Posterior lateral eyes with longitudinal diameter smaller than that of the anterior laterals in ratio 6: 7; one third their diameter from the latter. Posterior lateral eyes but little elongate; their longitudinal diameter fully five sixths as great as that of the laterals; nearer the laterals than to the anterior medians.

Labium densely spinulose across distal border as usual.

Metatarsi I and II scopulate to base, III to middle and IV sparsely scopulate at very end only.

First leg of male with metatarsus straight, not bowed dorsad, a little shorter than the tibia. Superior process of tibia stout, acuminate from base. Inferior process less than twice as long as the superior, curving mesad as well as dorsad, the two processes scarcely divergent.

Tibia of male palpus moderately thickened. Bulb of palpal organ on ectal side reddish brown while either the proximal portion of or the entire stylus is black. Stylus in side view bent at right angles to its base, curving a little forward toward middle and ventrad; in anterior view bent moderately ectad at middle; compressed but narrow, gradually attenuated distad.

Male (type). Length, 39 mm.

Cephalothorax: length, 19 mm.; width, 17.1 mm.; length of pars cephalica 13 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	18 mm.	23 mm.	13.3 mm.	8.6 mm.	62.9 mm.
Leg II	17	21.2	13.1	8.6	59.9
Leg III	14.2	18	13.3	7.3	52.8
Leg IV	18	23	19.5	8.5	69

Length of tibia I 13.8 mm.

Female. Length, 48 mm.

Cephalothorax: length, 19 mm.; width, 16.2 mm.; pars cephalica in length 13 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	14.2 mm.	20 mm.	10 mm.	6.2 mm.	50.4 mm.
Leg II	23.3	17.1	9.3	6	45.7
Leg III	12	15.1	11	6	44.1
Leg IV	15.4	20	16	7	58.4

Length of tibia I 12 mm.

This is readily separated from other Central American and Mexican species in which metatarsus I in the male is straight in having metatarsus IV shorter than the carapace instead of being much longer and in having that joint decidedly shorter than tibia + patella IV.

EURYPELMA HESPERA,[1] sp. nov.

Type.— M. C. Z. 48. ♀. Mexico: West Coast. Captain Goff. Ship DOOLEY.

Paratype.— M. C. Z. 59. ♀. Mexico: West Coast. Captain Goff. Ship DOOLEY.

Integument of carapace, sternum, and appendages chestnut. Pubescence of carapace thick, brown of bronze lustre. Pubescence of legs uniform, without lighter stripes. Bristles of legs and abdomen of a more reddish cast.

Eye-tubercle low. Eye-area very nearly twice as wide as long (45: 23); anterior and posterior eye-rows equal in length. Anterior row of eyes viewed from in front moderately procurved, a line tangent to the lower edges of median eyes intersecting upper border of lateral eyes; viewed from above a line tangent to the anterior edges of median eyes passes near middle of surface of laterals. Anterior median eyes with diameter smaller than that of the laterals in ratio 3:4; not quite two thirds their diameter apart, less than their radius from the lateral eyes. Posterior lateral eyes smaller than the anterior laterals, their diameters comparing as 13: 16; about their radius from the anterior ones. Posterior median eyes very much smaller than the laterals, the diameters being as 8: 13; somewhat nearer lateral eyes than to the anterior medians; but little elongate, somewhat obliquely truncate caudad. A line tangent to caudal edges of the two posterior eyes one each side intersecting the anterior median eye of the opposite side

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[1] ἕσπερος, western.

Metatarsi I and II scopulate to base; III for two thirds of length; and IV for about one third of length.

Female (type). Length, 35 mm.

Cephalothorax: length, 15.5 mm.; width, 13.2 mm.; length of pars cephalica 9.2 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	12 mm.	15.1 mm.	8.5 mm.	5.7 mm.	41.3 mm.
Leg II	10.8	14	8.1	5.6	38.5
Leg III	9.2	13.25	9	6	37.45
Leg IV	12.7	16.1	13	6.6	48.4

Tibia I 9 mm. long.

EURYPELMA AUREOCEPS,[1] sp. nov.

Plate 4, fig. 3.

Type.—M. C. Z. 43. ♀. Florida: Tortugas. J. B. Holder.

Integument of cephalothorax, legs and palpi dark chestnut excepting the brighter more reddish ventral surface of coxae of palps; that of the chelicerae black. Pubescence of carapace thick, tufted, and somewhat woolly, of a golden brown color as is that of the chelicerae. Pubescence of the legs brown of a less distinctly golden lustre excepting that of the indistinct longitudinal streaks on dorsal surface of the joints; more greyish on ventral surface of femora. Pubescence of sternum velvety brown, that of ventral surface of legs similar but with some grey intermixed. Fringe of endites bright copper-red. Pubescence of abdomen thick, dorsally and laterally brown, in part more or less of golden lustre. Bristles of legs and abdomen long, in the type mostly curved or wavy distally, of a yellow cast, more brown proximally.

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[1] *aureus*, golden, *-ceps*, head.

Eye-tubercle not high. Ocular area just twice as wide as long; anterior row of eyes a little longer than the posterior. Anterior row of eyes viewed from in front moderately procurved, a line tangent to the lower edges of the median eyes touching or intersecting the upper part of laterals. Anterior median eyes with diameter less than that of the laterals in ratio 2: 3; two thirds their diameter apart and closer, only their radius, from the laterals. Posterior lateral eyes smaller than the anterior, their diameters comparing as 4: 5; less than their radius from the anterior ones. Posterior median eyes much smaller than the laterals, the ratio of diameters being about 1.4: 2; subcircular except for the flattening of the anterior side; much closer to the lateral eye than to the anterior median eye. A line tangent to caudal edges of the two posterior eyes of each side intersecting the anterior median eye of opposite side.

Metatarsi I and II densely scopulate to base; metatarsus III scopulate three fourths the length toward base; and metatarsus IV more sparsely scopulate at distal end only.

Female (type).— Length, 44 mm.

Cephalothorax: length, 19 mm.; width. 17 mm.

	fem.	tib. +pat.	met.	tar.	total
Leg I	13.8 mm.	18.6 mm.	8.8 mm.	6 mm.	47.2 mm.
Leg II	12.5	16.5	8.8	5.7	43.5
Leg III	12	15.1	9.8	6	42.9
Leg IV	14.3	18.4	13.8	6.1	52.6

Length of tibia I 10.8 mm.

Lasiodora differens,[1] sp. nov.

Plate 4, fig. 4–5.

Type.— M. C. Z. 66. ♀. Brazil: Minas Geraes; Lagoa Sancta. Nathaniel Thayer Exped.

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[1] *differo,* diverge, differ.

Integument of cephalothorax and legs chestnut; that of the chelicerae black excepting for a reddish tinge ventrally along the fringe; labium black proximally. Pubescence of these parts brown and grey intermixed, the grey showing especially on the ventral surfaces of the femora. Bristles brown, paler, greyish, distally.

Cephalothorax a little longer than tibia + patella IV but decidedly shorter than tibia patella I.

Eye-tubercle decidedly less elevated and proportionately broader than in *L. klugii*. Anterior row of eyes viewed from above procurved in such degree that a line tangent to the anterior edges of the median eyes passes through or very near to center of surface of each lateral eye. Anterior median eyes a little smaller than the lateral (ratio of diameters 13: 14); less than their diameter apart (10: 13); nearly same distance from the lateral eyes. Posterior lateral eyes with diameter nearly equalling that of the anterior laterals from which they are separated by nearly two thirds their diameter. Posterior median eyes with long diameter a little smaller than that of the laterals; closer to the laterals than to the anterior medians. A line tangent to the caudal edges of the two posterior eyes on each side passing caudad of the anterior median eye of the opposite side.

Cuspules on labium dense and numerous as usual.

Stridulating spines of coxa I fewer than in *L. klugii* and not found at distal end of joint; very long and stout, mostly curving, appressed, acuminate and not at all spatulate, plumose only distally (Plate **4**, fig. 4). Plumose hairs dense on trochanter I and also occurring on mesal surface of femur from base well toward distal end. Plumose hairs likewise occurring on trochanter and femur of palpus.

Female (type).— Length, cir. 60 mm.

Cephalothorax: length 25 mm.; width, 23 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	19 mm.	26.8 mm.	13.2 mm.	8.5 mm.	67.5 mm.
Leg II	17.6	23.7	13	8.2	62.5
Leg III	16.1	21	14	8.3	59.4
Leg IV	19.5	24.6	20	9	73.1

Differs from *L. klugii* (C. Koch) in its flatter and broader eye-tubercle; in its shorter cephalothorax as compared with tibia + patella I which exceeds it decidedly whereas it is shorter in *L. klugii;* in its stouter legs; etc.

LASIODORA CURTIOR,[1] sp. nov.

Plate **4**, fig. 6, 7.

Type.— M. C. Z. 63. ♀. Brazil: Rio de Janeiro; Vassouras, March, 1871. B. P. Mann.

Paratype.— M. C. Z. 64. ♀. Brazil: Rio de Janeiro; Vassouras, March, 1871. B. P. Mann.

Integument of cephalothorax, legs, palpi, and chelicerae dark chestnut; endites ventrally distinctly lighter as usual, more pinkish. Pubescence mouse colored. Bristles brown, lighter distally. Hairs of fringe of chelicerae and endites rust-red.

Cuspules of labium and endites as usual.

A line tangent to anterior edges of anterior median eyes passes in front of middle of surface of each lateral eye. Anterior median eyes equal in diameter to the laterals; their radius or slightly more apart and an equal distance from the lateral eye on each side. Posterior lateral eyes equal in long diameter to the anterior laterals, from which they are separated by a little less than their radius. Posterior median eyes with diameter smaller than that of the laterals in about ratio 10: 13; very close to the lateral eye, distinctly farther from the anterior median eye on each side. Posterior median eye situated well caudad so that a line tangent to its caudal edge and that of the lateral eye of the same side passes caudad of the anterior median eye of the opposite side. Ocular area wider than long in the ratio 55: 28; slightly wider behind than in front (55: 53).

Stridulating spines mostly varying in length, shorter, and decidedly relatively more slender than in *L. differens* (Plate **4**, fig. 6) and also more numerous; also extending farther distad on the joint than in that species. Plumose hairs found on trochanter and most of femur as usual.

Female (type). Length of cephalothorax, 19 mm.; width, 17 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	14.5 mm.	20 mm.	10.1 mm.	7 mm.	51.5 mm.
Leg II	13	17.3	9.2	6.8	46.6
Leg III	12.1	16	10.1	6.3	44.5
Leg IV	15	20	15.6	7	58.3

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[1] *curtus*, short.

This is a considerably smaller species than *L. differens*. Tibia + patella I equals the sum of the corresponding joints of leg IV and exceeds the length of the cephalothorax whereas in *L. differens* tibia + patella I is much longer than tibia + patella IV and decidedly exceeds in length the cephalothorax which in turn is a little longer than tibia + patella IV. The eyes of the anterior row are clearly closer together. The stridulating spines of the coxa are smaller and more numerous.

PHORMICTOPUS CUBENSIS, sp. nov.

Type.— M. C. Z. 79. ♀. Cuba: near Havana? Felipe Poey.
Paratype.— M. C. Z. 82. ♀. Cuba: 1864. Mrs. Brown.

Integument of cephalothorax and legs very dark dull chestnut to black. Pubescence brown with grey intermixed on legs as usual. Bristles rust-brown. The fringe of light hairs across ends of joints above very narrow. The usual longitudinal bristle-free streaks on joints of legs above.

Cephalothorax with pars cephalica low as usual. In profile the pars cephalica is seen to rise convexly back of eye-tubercle, not descending immediately from the tubercle as in *P. cancerides*. Cephalothorax longer than either tibia + patella I or tibia + patella IV.

Anterior row of eyes rather weakly procurved in dorsal view; a line tangent to anterior edges of median eyes passes through anterior fourth of lateral eyes. Anterior median eyes with diameter but slightly smaller than that of the lateral (at least 9: 10); their radius or slightly more from each other and from the lateral eyes. Posterior lateral eyes equal in diameter to the anterior laterals from which they are separated by a distance equal to a radius. Posterior median eyes a little smaller than the lateral to which it is very close, or practically equal in long diameter. A line tangent to caudal edges of two posterior eyes on each side intersecting the anterior median eye of opposite side, the median eye not being situated so far caudad relatively as in *P. cancerides*.

Coxa I on anterior surface above suture with bacilliform plumose stridulating spines numerous and in a number of close and irregular series. Femur I on anterior side with a conspicuous scopula of densely arranged plumose hairs. Palpus with corresponding stridulating bristles on coxa and trochanter and also with plumose hairs on ectal surface of femur at base.

Metatarsi I and II scopulate to base; metatarsus III scopulate over distal two thirds of length; and metatarsus IV scopulate only at apex.

Female (type).— Length, 68 mm.

Cephalothorax: length, 28 mm.; width, 23 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	16.6 mm.	22.8 mm.	12 mm.	7 mm.	58.4 mm.
Leg II	15.2	20.5	12	7	54.7
Leg III	14	19	13	7.2	53.2
Leg IV	16	22.5	18.7	8	65.2

This species differs from *P. cancerides* (Latr.) and *P. nesiotes*, sp. nov. and agrees with *P. cautus* (Auss.) in having plumose hairs on the anterior surface of femur I. It is in some degree possible that the present species may be *P. cautus* Ausserer; but unfortunately the latter species was based upon males only, while of the present one only the female is known so that comparison cannot be wholly satisfactory, especially since the locality from which the type of *P. cautus* came is wholly unknown.

PHORMICTOPUS NESIOTES,[1] sp. nov.

Plate **4**, fig. 8, 9.

Type.— M. C. Z. 80. ♂. Cuba: 1864. Mrs. Brown.

Paratypes.— M. C. Z. 81. Two ♀ ♀. Cuba: 1864. Mrs. Brown.

Integument of cephalothorax and legs dull dark chestnut. Pubescence mostly a somewhat golden brown with some grey intermixed this being more abundant ventrally on the femora especially. Legs with the usual longitudinal lighter streaks on joints above, these showing well on patellae and tibiae especially.

Anterior row of eyes in dorsal view procurved; a line tangent to anterior edges of median eyes passing well in front of middle of lateral eyes. Anterior median eyes with diameter exceeding that of the laterals in about ratio 13: 11; their radius apart and closer to the laterals. Posterior lateral eyes a little smaller than the anterior laterals, from which they are separated by much less than their diameter. Posterior median eyes elliptic; subcontiguous with the laterals which are only slightly larger.

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[1] νησιώτης, an islander.

The plumose bacilliform bristles of the stridulating organ occurring on coxae of palpus and first legs as well as on the trochanters as usual. No plumose hairs are present on the anterior surface of leg I.

Metatarsus I and II scopulate to base, III to middle, and IV only at distal end.

Leg I in the male with the metatarsus straight. Inferior process of tibia long and of moderate slenderness, curving away from joint and then more strongly dorsad; the metatarsus when joint is flexed closes against the adaxial surface of tip of this process. Superior tibial process much shorter and proportionately stouter than the inferior one toward which it is slightly bent, relatively considerably shorter than the corresponding process in *P. cancerides*.

Tibia of the palpus in the male moderate in thickness, narrowest distad; bearing on ectal side a broad, low, and rounded tubercular elevation which is proportionately larger than that in *P. cancerides*, but is considerably less conspicuous than that in species of Acanthoscurria. Spine of bulb of palpal organ long, uniformly narrowing toward tip, curving rather strongly but evenly toward distal end, smooth.

Male (type).— Length, 35 mm.

Cephalothorax: length, 18.2 mm.; width, 17 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	16 mm.	20 mm.	13.2 mm.	8.6 mm.	57.8 mm.
Leg II	15	19.2	13	——	——
Leg III	13	17	14	7.2	51.2
Leg IV	16	20.3	19	8	63.3

Female.— Length, 36 mm.

Cephalothorax: length, 17.5 mm.; width, 15.6 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	13.7 mm.	18 mm.	9.3 mm.	6 mm.	47 mm.
Leg II	13	16.2	9.3	6	44.5
Leg III	11.7	15.2	10.8	6	43.7
Leg IV	14	18.3	15	6.3	53.6

This species is like *P. cancerides* (Latr.) in lacking plumose hairs on the anterior surface of femur I; but it is a much smaller species and in the male differs in having metatarsus I straight instead of conspicuously bowed; in the smaller proportionate length of the upper tibial process; in the more marked tubercle on tibia of palpus; etc.

PHORMICTOPUS MELODERMA,[1] sp. nov.

Type.— M. C. Z. 85. ♀. West Indies?

Integument of entire carapace, sternum, chelicerae, palpi, and legs when dry a dense black, when in alcohol showing in parts a faint reddish tinge. Ventral surface of endites along mesal half reddish or pink. Pubescence brown with a little grey intermixed; the light stripes across ends of joints above very narrow. Bristles of legs and abdomen reddish brown.

Anterior row of eyes procurved in such degree that a line tangent to anterior edges of the median eyes passes through or a little behind middle of surface of lateral eyes. Anterior median eyes with diameter only four fifths that of the laterals; four fifths their diameter apart and closer to, about three fifths their diameter from, the laterals. Posterior lateral eyes with diameter about four fifths that of the anterior ones, separated from the latter by about two thirds their diameter or by radius of anterior eye. Posterior median eyes about equal to the laterals; nearer to lateral eye than to anterior median eye of same side.

Sternum longer than wide in ratio 12.2 : 10.8; but weakly convex.

Stridulating bristles on coxa I long, plumose, somewhat clavate, in type 5 in number. Stridulating bristles on coxa of palpus of the same form, 6 or 7 in number.

No plumose hairs on anterior surface of femur I.

Metatarsus of legs I and II scopulate to base or very nearly so; metatarsus III scopulate three fourths the length toward base; and metatarsus IV scopulate for only about one fifth of length at distal end.

Female (type).— Length, 60 mm.

Cephalothorax: length, 27 mm.; width, 24.2 mm.; width at level of eyes, 16.5 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	20 mm.	26.2 mm.	13.6 mm.	8.6 mm.	68.4 mm.
Leg II	19	24	13.2	9	65.2
Leg III	17	21.5	15.2	9.2	62.9
Leg IV	20	25.3	21	10	76.3

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[1] μέλας, black, dusky, δέρμα, skin, integument.

PHORMICTOPUS PLATUS,[1] sp. nov.

Type.— M. C. Z. 85. ♀. Florida: Tortugas. J. B. Holder.

Paratype.— M. C. Z. 84. ♀. Florida: Tortugas. J. B. Holder.

Integument of cephalothorax and legs when dry black or nearly so, a weak reddish tinge becoming evident when in alcohol; that of endutes beneath pinkish. Pubescence brown with a lesser amount of grey intermixed. Bristles as usual.

Eye-tubercle high and convex. Anterior row in dorsal view nearly straight; a line tangent to anterior edges of median eyes passes through anterior fourth of the laterals. Anterior median eyes equal in diameter to the lateral ones; their radius or slightly more apart, closer to the lateral eyes. Posterior lateral eyes slightly smaller than the anterior laterals from which they are removed by a distance equal to their radius. Posterior median eyes closer to the lateral eyes than to the anterior medians situated much as in *P. cancerides.* A line tangent to caudal edges of the two posterior eyes on each side passes much behind anterior median eye of the opposite side.

Plumose hairs on femur I more slender and relatively longer and more prone in habit than in *P. cubensis;* fewer in number and with simple hairs intermixed.

Female (type).— Length, 52 mm.

Cephalothorax: length, 22.5 mm.; width, 20.2 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	16 mm.	22.7 mm.	13.2 mm.	7.3 mm.	59.2 mm.
Leg II	15.6	21	13	7	56.6
Leg III	14.3	19	13.7	6.7	53.7
Leg IV	17	22.5	17.2	7.3	64

A second female from the Tortugas, probably the same species differs in having proportionately smaller legs with the cephalothorax somewhat exceeding in length tibia + patella I and tibia + patella IV; its anterior row of eyes is a little more procurved and the posterior median eyes are a little farther forward; but these differences are probably due to individual variation.

This species is like *P. cubensis* and *P. cautus* in having plumose hairs on the femur of leg I; but these hairs are fewer and more slender than in *P. cubensis* and do not form so dense a scopula, not extending distad beyond middle of joint. The pars cephalica is more depressed and the cephalothorax proportionately wider. The type also differs from *P. cubensis* in having the cephalothorax equal in length to tibia + patella IV, not distinctly and considerably longer though exceeding these joints a little in the second female mentioned above.

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[1] πλατύς, broad.

ACANTHOSCURRIA NATALENSIS, sp. nov.

Type.— M. C. Z. 88. ♀. Brazil: Rio Grande do Norte; Natal. Stanford 1911 Exped. to Brazil. W. M. Mann.

Integument of carapace, sternum, legs, palpi, and chelicerae very light chestnut. Carapace and sternum clothed with a dense coat of velvety brown pubescence. Legs clothed chiefly with similar pubescence but grey abundant and predominating on ventral surface of the femora; ends of joints above with the usual very narrow fringe of cream-colored hairs. Bristles numerous, long, rust-brown in color. Abdomen very densely clothed with dark mouse-colored pubescence which is somewhat lighter beneath; the usual long rust-brown bristles above and laterally.

Pars cephalica relatively high, convex.

Anterior row of eyes only weakly procurved, a line tangent to anterior margins of median eyes passing considerably in front of middle of lateral eyes. Anterior median eyes with diameter scarcely differing from the long diameter of the laterals which are elliptic; their diameter apart but only about two thirds their diameter from the laterals. Posterior lateral eyes equalling the anterior ones or scarcely smaller, from these being separated by about their radius. Posterior median eyes small, about two thirds the diameter of the laterals to which they are closer than to the anterior medians.

Spinules on labium and endites of usual form and arrangement.

Sternum of moderate convexity.

Metatarsi I and II scopulate very nearly to base; metatarsus III scopulate from one half to two thirds of its length; and metatarsus IV not at all scopulate.

Female (type).— Length, 48 mm.

Cephalothorax: length, 19.25 mm.; width 16.2 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	13.2 mm.	17.7 mm.	9.2 mm.	5.2 mm.	45.5 mm.
Leg II	12	16	8.2	5.2	41.4
Leg III	11	14	10	5.3	40.3
Leg IV	13	17	14	5.6	49.6

Distinct especially in the proportionate sizes and distances of the eyes; in the more strongly elevated pars cephalica; the complete absence of scopula from metatarsus IV, etc.

ACANTHOSCURRIA CURSOR,[1] sp. nov.

Plate 4, fig. 10.

Type.— M. C. Z. 92. ♂. Brazil: Ceará; Maranguape Mts. Stanford 1911 Exped. to Brazil. W. M. Mann.

Paratype.— M. C. Z. 90. ♂. Brazil: Ceará; Maranguape Mts. Stanford 1911 Exped. to Brazil. W. M. Mann.

Integument of cephalothorax and legs dark chestnut, in parts almost blackish. Pubescence of body in general dark mouse colored, grey intermixed especially on ventral surfaces of femora as usual. Bristles rufous brown, those forming the fringes on endites and chelicerae brighter red. The whitish fringe across distal ends of joints above very narrow. Darker than in most species of the genus.

Anterior row of eyes weakly procurved, a line tangent to anterior edges of median eyes in dorsal view passing a little in front of middle of laterals. Anterior median eyes with diameter clearly and considerably less than that of the laterals (ratio cir. 13: 17); less than their diameter apart (10: 13), closer to the laterals. Posterior lateral eyes slightly larger in long diameter than the anterior lateral ones (13: 12). Posterior median eyes very close to the laterals and also to the anterior medians from which they are but little farther removed.

Anterior surface of femur I with plumose hairs over entire length, these becoming more and more numerous proximad, sparse distad; plumose hairs similarly occurring over entire length of caudal surface of femur of palpus.

Tibial process of leg I in the male large, diverging more than in *A. fracta* and larger and proportionately narrower than in *A. minor;* distally presenting 9 or more closely appressed spinous divisions.

Tibia of palpus of male moderately enlarged, narrowed distad; ectal tubercle low and stout, acute, triangular in outline with the anterior and caudal sides straight; higher than in *A. minor*. Spine of bulb much longer than in *A. minor,* without the conspicuous spiral carinal elevation; a single short spinous tip with a moderate rounded bulging plate at its base as shown in the figure but not truly bifid and not at all retrorse as in *A. geniculata.*

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[1] *cursor*, a runner.

Male (type). Length, 38 mm.

Cephalothorax: length, 19 mm.; width, 17 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	18 mm.	23.2 mm.	14.2 mm.	8 mm.	63.4 mm.
Leg II	16.7	21	13.2	8	58.9
Leg III	14.2	18	14.5	7.4	54.1
Leg IV	17	21	19.5	9	66.5

ACANTHOSCURRIA FRACTA,[1] sp. nov.

Plate 5, fig. 1.

Type.— M. C. Z. 87. ♂. Brazil: Pará; Pará. Nathaniel Thayer Exped.

Integument of cephalothorax and appendages chestnut with the reddish element pronounced. Pubescence of entire body dense and velvety, mouse colored, more greyish on ventral surface of femora especially. Bristles numerous, rust-brown.

Anterior row of eyes procurved in such degree that a line tangent to anterior edges of median eyes passes through or very near to middle of the laterals. Anterior median eyes slightly smaller than the laterals (diameters as 16: 17); scarcely three fourths their diameter apart and not fully their radius from the laterals. Posterior lateral eyes with diameter only about three fourths that of the anterior ones. Posterior median eyes with long diameter about equal to that of the anterior medians; very close to lateral eyes, farther from the anterior medians.

Labium and endites of palpi as usual.

Metatarsus I scopulate very nearly to base; II scopulate about five sixths of length; III about one half of length; and metatarsus IV less densely scopulate only at distal end.

Process on tibia I in the male curving and distally becoming parallel with axis of joint; in the type the process is distally partite with four long stout acute teeth with dorsad of these and also on mesal surface a number of stiff bristle-like bodies as shown in figures.

Tibia of palpus of male inflated, moderately narrowing distad; its exterior tubercle stout, short, with anterior edge concave and the posterior edge distally convex so that the apex appears slightly bent forward. Bulb globose; spine short, at apex with a short acute point at the base of which is a semicircular, disc-like carinal elevation in place of the somewhat retrorse process in *A. geniculata*, proximally with a slightly raised spiral edge.

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[1] *frango*, break.

Male (type). Length, 50 mm.

Cephalothorax: length near, 21 mm., its broken condition making more than an approximation impossible.

	fem.	tib. + pat.	met.	tar.	total
Leg I	21 mm.	28.5 mm.	18.7 mm.	10 mm.	78.2 mm.
Leg II	20	26	17	9.5	72.5
Leg III	18	22.1	18.5	9.3	67.9
Leg IV	20.2	26.3	23.6	9.8	79.9

This species is like *A. geniculata* in having numerous plumose hairs over entire length of femur I on the anterior side. From that species it differs in the male palpal organ and in having the white stripe across ends of joints narrower, etc.

ACANTHOSCURRIA DUBIA,[1] sp. nov.

Type. M. C. Z. 93. ♀. Habitat unknown.

Carapace dark chestnut, clothed densely with intermingled grey and reddish brown pubescence. Chelicerae with similar pubescence, the grey prevailing above, and in addition with numerous long reddish bristles along mesal part of dorsal surface and over entire anterior surface above base of claws; bristles of the fringe reddish. Sternum chestnut densely clothed with brown pubescence and longer brown bristles. Legs densely clothed with velvety grey and brown pubescence intermixed and very numerous long rufous bristles. The bristles, especially on patellae and tibiae, tend to be absent from longitudinal stripes (paired) which in consequence appear as lighter grey streaks. Ends of joints above with lighter transverse narrow band of hair. The abdomen with the usual dense velvety coat of pubescence, brown with much grey intermixed; numerous long rufous bristles above and laterally.

Cephalothorax longer than tibia + patella I; a little narrower than tibia + patella IV.

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[1] *dubius*, doubtful.

Sternum a little longer than wide (11: 10).

Labium and endites with the spinules as usual.

Ocular tubercle convex. Anterior row of eyes only weakly procurved a line tangent to anterior edge of median eyes running clearly in front of the middle of the lateral eyes. Anterior median eyes subequal to the laterals; less than their diameter apart and from the lateral on each side. Posterior lateral eyes a little smaller than the anterior laterals. Posterior median eyes but little smaller than the posterior laterals to which they are a little closer than to the anterior medians.

Metatarsi I and II scopulate densely to base; metatarsus III scopulate a little more than half its length; metatarsus IV scopulate only at very distal end.

Femur I with some plumose hairs on anterior side proximally but none detected on ectal side of femur of palpus. Bacilliform spines of stridulating organ on trochanter of palpus very numerous.

Female (type).— Length, 55 mm.

Cephalothorax: length, 25.5 mm.; width, 22 mm.; width across anterior end 15 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	17.5 mm.	23.8 mm.	12.3 mm.	7 mm.	60.6 mm.
Leg II	16	21.5	11.7	7	56.2
Leg III	14.5	19	14	7.6	55.1
Leg IV	18	23	18	8	65

SELENOCOSMIA KULLUENSIS, sp. nov.

Plate 5, fig. 2, 3.

Type.— M. C. Z. 94. ♂. India: Kullu Valley. M. M. Carleton.

Integument of cephalothorax and legs chocolate-brown. Pubescence of legs in general lighter yellowish brown; the patellae clothed with white or greyish hairs a stripe of which also encircles tibiae at proximal end. Pubescence of cephalothorax dense; in large part light grey in color, this being most abundant cephalad, also occurring over part of chelicerae. Sternum and coxae of legs ventrally lighter brown. Abdomen above light brown with hairs yellowish brown; venter a deeper chocolate-brown. The fringes on endites and chelicerae rufous.

Labium with a dense band of spinules across distal border. Coxae of palpi with similar spinules over proximomesal corner.

Cephalothorax low. Pars cephalica but little elevated. Fovea thoracic short, lunate.

Anterior row of eyes very weakly procurved, a line tangent to median eyes passing through anterior fifth of lateral eyes. Median eyes smaller than the lateral, the ratio of diameters being nearly as 7:8; nearly four sevenths their diameter apart while only little more than one third their diameter from the laterals. Posterior row of eyes recurved. Posterior lateral eyes smaller than the anterior laterals, the ratio of diameters being about as 25:34; three fourths their diameter from the anterior laterals. Posterior median eyes very long and narrow, longer than greatest diameter of the laterals; very close to the laterals, clearly farther from the anterior medians.

Bacilliform spines of stridulating organ on coxa of pedipalp densely grouped in an elongate ovate area of which the narrower end is distad. The stridulating spines on the chelicera are arranged in an area adjacent to the fringe for the entire length of which they extend, the spines decreasing in length and increasing in density toward dorsal or ectal edge of the area.

Tibia + patella IV in male shorter than tibia + patella I; both considerably longer than the cephalothorax.

Tibia I in male unmodified as usual.

Male (type). Length, 39 mm.

Cephalothorax: length, 18 mm.; width, 15.5 mm.

	fem.	tib.+pat.	met.	tar.	total
Leg I	15 mm.	22 mm.	11 mm.	6.5 mm.	54.5 mm.
Leg II	13.5	19	10.3	6	48.8
Leg III	12	16	11	6	45
Leg IV	15	20.5	16	6.5	58

In coloration close to *S. himalayana* Pocock. It agrees with this form and differs from other known Indian species in having the patellae and cephalothorax covered with greyish hairs, the patellae contrasting sharply in color with other joints of legs. The present species seems to be a decidedly larger one than *S. himalayana* and the anterior row of eyes are procurved though not strongly so, instead of straight. The scopula of tarsus IV in *S. himalayana* is divided whereas it is entire in the present species excepting at very proximal end. Unfortunately the type of *S. himalayana* is a female, that of *S. kulluensis* a male, so that detailed comparisons cannot be made.

MELOGNATHUS,[1] gen. nov.

Anterior row of eyes distinctly procurved, with the median eyes clearly larger than the lateral. Posterior median eyes smaller than the lateral.

Fovea thoracica short; transverse. Cephalothorax low; pars cephalica scarcely elevated, not convex.

Vibratile bristles of stridulating organ on the chelicera few, in a series a little ectad of and parallel with the oral fringe, bacilliform. The stridulating spines of the opposite adjacent surface of coxa of pedipalp below suture arranged in two definite series close to and parallel with the suture, not at right angles to it as in Thrigmopoeus; those above the suture few, smaller, and scattered among plumose bristles (Plate 5, fig. 6).

All tarsi scopulate with no trace of a dividing setose band in the scopulae. Metatarsi of anterior legs scopulate nearly to base; metatarsi III and IV scopulate only at distal end. Metatarsi of posterior legs armed at distal end both above and below with stout spines. Tibia + patella I decidedly longer than tibia + patella IV.

Tibia I in the male is armed at distal end with a stout process which is curved and spinulose.

Type Species.— *Melognathus dromeus*, sp. nov.

MELOGNATHUS DROMEUS,[2] sp. nov.

Plate 5, fig. 4–7.

Type.— M. C. Z. 96. ♂. East Indies? Philippines? J. M. Barnard. Ship MONSOON.

Integument of cephalothorax and appendages reddish or chestnut; that of the abdomen brown. Pubescence of the body throughout dense; yellowish brown or light rust colored.

Cephalothorax low and flat; the pars cephalica not elevated. Fovea thoracica transverse, shorter than the width of the eye-area.

Eye-area twice as wide as long. Anterior row scarcely longer than the posterior one; strongly procurved in dorsal view. Anterior median eyes distinctly larger than the laterals. Eyes of the second row much the smallest, with the median smaller than the lateral. Posterior median eyes a little farther from anterior medians than from posterior laterals.

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[1] μέλας, black, γνάθος, jaw.

[2] δρομεύς, a runner.

Sternum equal in length and breadth.

Labium densely spinulose over distal half.

Coxae of pedipalps densely spinulose over proximomesal portion.

Process of tibia I in the male large; curved dorsad; the convex surface densely clothed with short spines.

Male (type). Length of cephalothorax 15.5 mm.; width, 14.5 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	22.5 mm.	28 mm.	15 mm.	8.8 mm.	74.3 mm.
Leg II	20	24	13.75	8.2	65.95
Leg III	——	—	——	——	——
Leg IV	19	23	17	7	66

POECILOTHERIA BARA,[1] sp. nov.

Type.— M. C. Z. 95. ♀. Ceylon. F. Layard.

Carapace chocolate-brown. Abdomen dorsally with a yellow hastate band, the sides of which are deeply wavy and bordered with black from which there are indications of black stripes extending obliquely across sides of the abdomen as in several related forms; the hastate band is bisected longitudinally with a dark stripe. Ventral surface of abdomen, coxae, and trochanters of legs and sternum deep chocolate. Femora of legs with a white band of hair across distal end above; patellae with a broad white band across proximal end and a much narrower one at distal end; tibiae with a relatively narrow band of white across each end; metatarsi each with a white band at proximal end, a broader one at distal end, and, extending between the two, a narrow, obliquely longitudinal stripe of same colored hair.

Fovea thoracica short; transverse or very slightly recurved.

Female (type).— Length, 60 mm.

Cephalothorax length, 30 mm.; width, 24 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	22 mm.	31 mm.	17 mm.	8 mm.	78 mm.
Leg II	22	30	18	8	76
Leg III	19.5	24	16	7	66.5
Leg IV	22.7	28	21	8	79.7

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[1] βαρὺς, heavy.

DIPLURINAE.

TRYSSOTHELE AUSTRALIS,[1] sp. nov.

Plate 5, fig. 8.

Type.— M. C. Z. 113. ♀. Chile: Talcahuano. Hassler Exped.

Paratypes.— M. C. Z. 114. One ♀, three immature ♀♀. Chile: Talcahuano. Hassler Exped.

Integument of carapace, sternum, legs, and pedipalps chestnut; that of the chelicerae black. Integument of abdomen black; dorsum crossed by four pairs of oblique light yellowish or testaceous stripes which do not meet at the median line. Pubescence of the carapace light brown of golden lustre; that of the legs similar but more brown. Spinnerets black. Fringe of endites and chelicerae brick-red.

Ocular area near twice as wide as long (40: 21).[2] Anterior row of eyes in dorsal view straight or very nearly so. Anterior median eyes considerably smaller than the lateral, the ratio of diameters being about 2: 3.; two thirds their diameter apart, and but half as far from the laterals. Posterior lateral eyes as large as the anterior laterals; lateral eyes on each side very close together, almost contiguous. Posterior median eyes with diameter two thirds that of the laterals, subcircular or but slightly elongate, nearer to the laterals than to the anterior medians.

Metatarsi I and II scopulate to base; metatarsus III scopulate only at end; and metatarsus IV not at all scopulate. Metatarsus II, in addition to apical spine beneath, with a pair of spines proximad of middle and one at the base. Numerous spines on metatarsi III and IV. Patella III armed with a spine on the anterior surface.

Female (type). Length, 22 mm.

Cephalothorax: length, 10.3 mm.; width, 8.1 mm.; length of pars cephalica, 6 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	7 mm.	10.1 mm.	4.8 mm.	3.4 mm.	25.3 mm.
Leg II	6.4	9.2	4.2	3.4	23.2
Leg III	6	8	5.8	3.3	23.1
Leg IV	7.8	10.2	8	4.25	30.25

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[1] *australis*, southern.

[2] On one side in the type specimen the two lateral eyes are coalesced and the area on that side thus shorter, the ratio to the width being only 7: 15.

BRACHYBOTHRIINAE.

BRACHYBOTHRIUM PUGNAX,[1] sp. nov.

Type.— M. C. Z. 115. ♀. Arizona: Tucson. Charles Bendire.

Carapace and legs light brown of dilute chestnut tinge. Chelicerae dusky chestnut. Sternum and coxae of legs beneath dusky brown. Abdomen light brown, dusky especially beneath; spinnerets yellowish.

Pars cephalica rather low, with the posterior declivity somewhat flattened; in profile moderately convex. Fovea thoracica short, very deep, radiating lines fine, more or less ramose and in part reaching the fovea.

Anterior median eyes with centers on or near the middle transverse line of ocular area; very close to and not much differing in size from the posterior median eyes.

Chelicerae moderate; the cephalothorax about two and a half times longer than their anteroposterior length. Rastellum composed of a moderate number of long, stout, distally curved spine-like teeth.[2] Hairs long and numerous on elevation at mesal side of the convex surface.

The femur of the palpus is conspicuously compressed laterally; the tibia is ventrally flattened over the distal portion, narrowed distad; tarsus similarly flattened and depressed at distal end beneath so that the more proximal portion protrudes as a lobe; tibia and tarsus strongly spined. Claw with four teeth.

Metatarsus I produced ventrad into a conspicuous, basally long and distally angular lobe a little proximad of middle, with a lower, keel-like edge extending from this lobe to the distal end of the joint; the lobe clothed with long fine hairs. Tibia I with a ventral ridge conspicuously highest near middle as in the metatarsus; on the tibial lobe are borne 5 or 6 long black spines in 2 series (2 + 3 or 2 + 4, the larger number being in the series on the mesal or anterior side).

Distal article of the superior spinnerets longer and clearly more slender than the median one.

Female (type). Length, 13 mm.

Cephalothorax: length, 7 mm.; width, 6 mm.

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[1] *pugnax*, pugnacious.

[2] No rastellum proper is present on the left chelicera in the type, though strongly developed on the right one. The left chelicera is smaller also.

	fem.	tib.+pat.	met.	tar.	total
Leg I	6 mm.	6.5 mm.	4.6 mm.	3.5 mm.	20.6 mm.
Leg II	5.2	5.5	4	2.5	17.2
Leg III	5.2	5.6	4.5	3.1	18.4
Leg IV	6.2	6.7	6.3	3.1	22.3

BRACHYBOTHRIUM HAGENI, sp. nov.

Plate 5, fig. 9.

Type.— M. C. Z. 116. ♂. Washington: Colville Valley; Loon Lake, 25 July, 1882. Samuel Henshaw.

Cephalothorax and legs brown of a dilute chestnut cast, the coxae of the legs ventrally dusky; palpi paler than the legs. Area between eyes blackish. Abdomen light or yellowish brown; dusky ventrally and over sides, leaving a slightly paler area above which is more or less broken into three spots. Spinnerets yellowish.

Posterior declivity of pars cephalica nearly straight, descending directly from the eyes to the fovea thoracica. The longitudinal fovea thoracica sharply impressed; radial lines distinct.

Eye-tubercle convex; moderate. Anterior median eyes as usual greatly smaller than the lateral, a little exceeded by the posterior median ones.

Chelicerae rather small; near middle of convex, anterodorsal, surface conspicuously elevated at mesal side and bearing a dense growth of long stout bristles.

Labium and the coxae of pedipalps not spinulose.

Tarsi of legs all slender, conspicuously curved or bent a little distad of middle. Spines of metatarsi long and slender, numerous. Claws armed with 6 or more teeth.

Tibia I subcylindric or very slightly clavate distad; on anterior side over middle third of length with a dense patch of long slender spines and a similar area on the posterior or ectal side covering an area between middle or a point a little distad of middle and the distal end; also bearing numerous longer and shorter black hairs. Proximal half of tibia II more slender than the distal.

Femur of palpus in the male long and slender, curved, laterally somewhat compressed. Patella moderate, much shorter and more slender than the tibia; 1.8 times longer than thick. Tibia thick, elongate, rounded at ends; about 2.65 times longer than thick and

1.8 times longer than the patella. Tarsus short, subhemispherical. Bulb of palpal organ subglobular or somewhat pyriform; spine stout, strongly curved, bifid toward end, showing on the mesal side a distally broadly rounded division with edge and surface finely denticulate or tuberculated, and on the ectal side an acutely pointed longer process.

Male (type). Length, 13 mm.

Cephalothorax: length, 6.4 mm.; width, 5.3 mm.

	fem.	tib. + pat.	met.	tar.	total
Leg I	5.6 mm.	6.6 mm.	4.1 mm.	2.8 mm.	19.1 mm.
Leg II	5	5.7	4	3	17.7
Leg III	4.8	5.2	4.5	3.2	17.7
Leg IV	5.6	6.6	6.1	3.2	21.5

Readily distinguished from *B. pacificum* Simon, also described from Washington, in having a dense patch of spines on both inner and outer surface of tibia I of male instead of only on the inner (anterior) surface, as well as in presenting pronounced differences in the palpal organ. From *B. robustum* Simon, which it seems most to resemble, it differs, among other points, in the palpal organ and in the modifications of leg I.

PLATE 1.

PLATE 1.

Pycnothele perditus Chamberlin.

Fig. 1. Right palpal organ of male, ectal view.
Fig. 2. Eyes, dorsal view.
Fig. 3. Spinnerets, ventral view.
Fig. 4. Labium and coxa of left palpus in outline, ventral view.

Actinopus xenus Chamberlin.

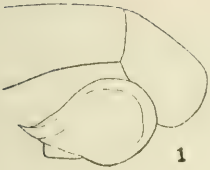
Fig. 5. Eyes, dorsal view.

Pachylomerus tuobitus Chamberlin.

Fig. 6. Right palpal organ of male, ventral view.
Fig. 7. The same, ectal view.
Fig. 8. Eyes, dorsal view.

Lechrictenus lamprus Chamberlin.

Fig. 9. Eyes, dorsal view.
Fig. 10. Portion of third leg of right side, caudal view, showing tibia and metatarsus.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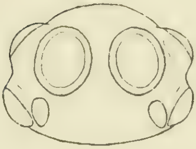
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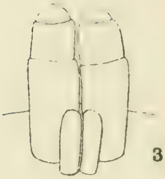
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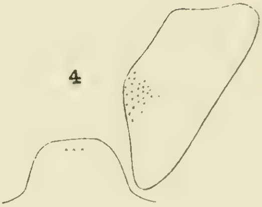
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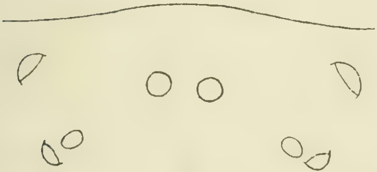
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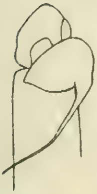
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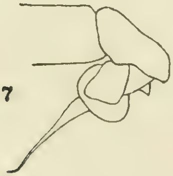
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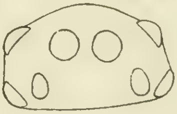
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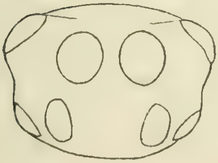
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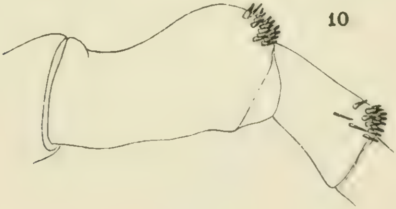
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PLATE 2.

PLATE 2.

Lechrictenus lamprus Chamberlin.

Fig. 1. Rastellum of left chelicera, anterior view.

Aptostichus simus Chamberlin.

Fig. 2. Eye-tubercle and eyes, lateral view.
Fig. 3. The same, dorsal view.

Cyrtopholis medius Chamberlin.

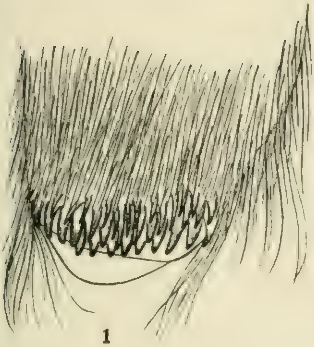
Fig. 4. Stridulating bristle from trochanter I. (Male paratype).
Fig. 5. Left palpal organ of male, ectal view.
Fig. 6. Tibial spurs of left leg I of male, mesal view.

Cyrtopholis portoricae Chamberlin.

Fig. 7. Eyes, dorsal view.

Cyrtopholis pelus Chamberlin.

Fig. 8. Tibial spurs of right leg I of male, mesal view.
Fig. 9. Stridulating bristle from trochanter I.
Fig. 10. Right palpal organ of male, ectal view.



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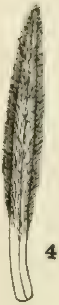

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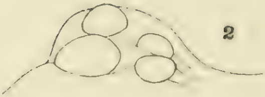

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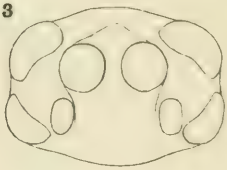

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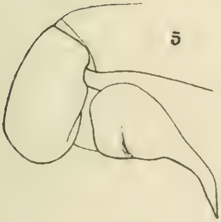

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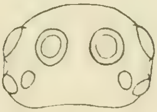

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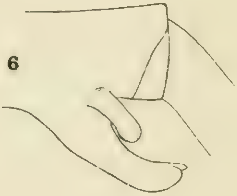

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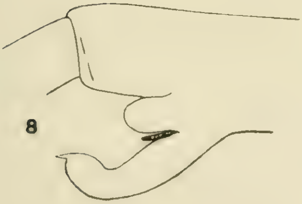

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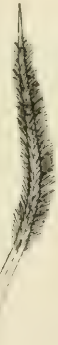

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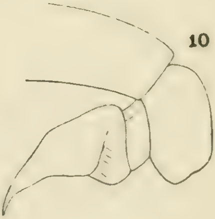

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PLATE 3.

PLATE 3.

Cyrtopholis annectans Chamberlin.

Fig. 1. Right palpal organ of male, ectal view.
Fig. 2. Stridulating bristle from trochanter I. (Female paratype).

Calopelma brasiliana Chamberlin.

Fig. 3. Right palpal organ of male, ectal view.
Fig. 4. Tibial spurs of leg I, mesal view.

Grammostola chalcothrix Chamberlin.

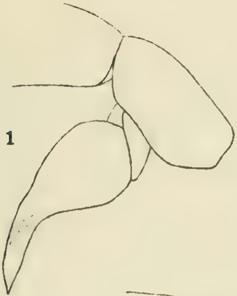
Fig. 5. Right palpal organ of male, ectal view.
Fig. 6. Stridulating bristle from coxa I.
Fig. 7. Eyes, dorsal view.

Grammostola cala Chamberlin.

Fig. 8. Left palpal organ, ectal view.
Fig. 9. Stridulating bristle from coxa of palpus.

Eurypelma latens Chamberlin.

Fig. 10. Right palpal organ, ectal view.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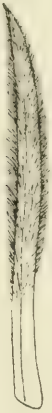
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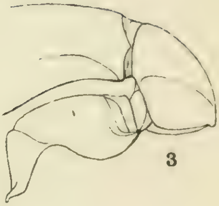
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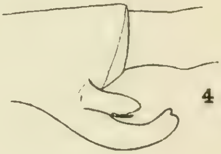
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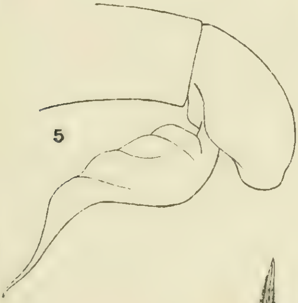
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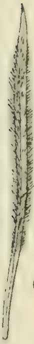
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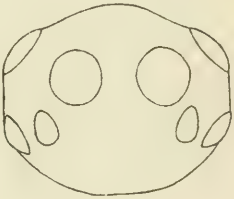
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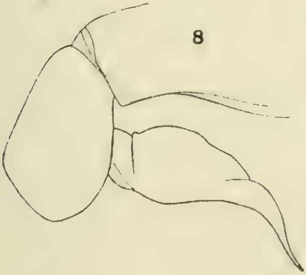
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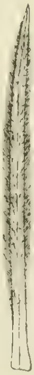
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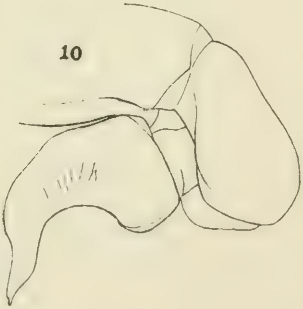
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PLATE 4.

PLATE 4.

Eurypelma regina Chamberlin.

Fig. 1. Right palpal organ, ectal view.

Eurypelma aberrans Chamberlin.

Fig. 2. Eyes, dorsal view.

Eurypelma aureoceps Chamberlin.

Fig. 3. Eyes, dorsal view.

Lasiodora differens Chamberlin.

Fig. 4. Stridulating bristle from coxa I. (Female, type).
Fig. 5. Eyes, dorsal view.

Lasiodora curtior Chamberlin.

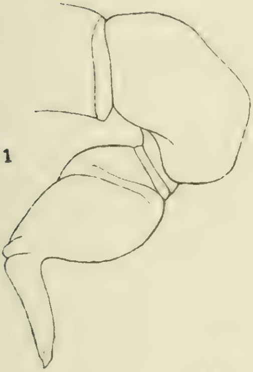
Fig. 6. Stridulating bristle from coxa I. (Female, type).
Fig. 7. Same, smaller example.

Phormictopus nesiotes Chamberlin.

Fig. 8. Right palpal organ, ectal view.
Fig. 9. Tibial spurs of left leg I of male, mesal view.

Acanthoscurria cursor Chamberlin.

Fig. 10. Right palpal organ of male, ectal view.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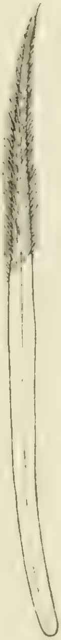
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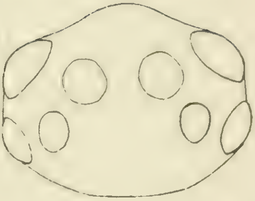
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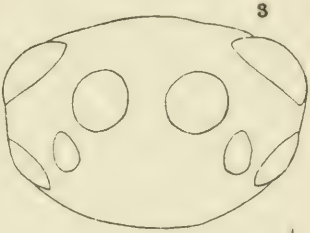
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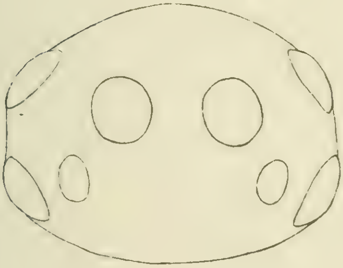
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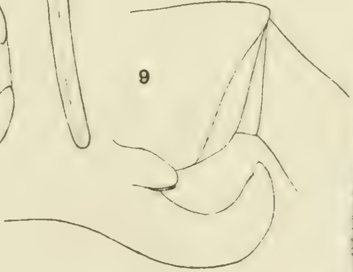
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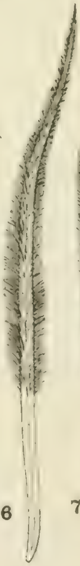
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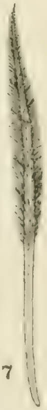
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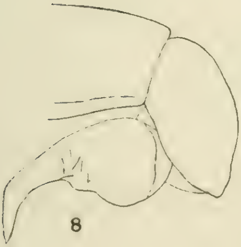
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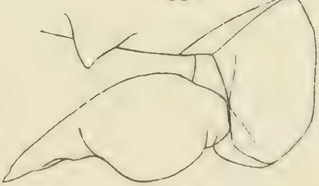
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PLATE 5.

PLATE 5.

Acanthoscurria fracta Chamberlin.

Fig. 1. Right palpal organ, ectal view.

Selenocosmia kulluensis Chamberlin.

Fig. 2. Left palpal organ, ectal view.
Fig. 3. The same, ventral view.

Melognathus dromeus Chamberlin.

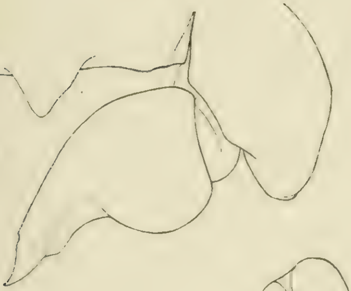
Fig. 4. Eyes, dorsal view.
Fig. 5. Right palpal organ, ectal view.
Fig. 6. Coxa of palpus, mesal (anterior) view, showing the stridulating spines and plumose hairs.
Fig. 7. Tibial process of right leg I of male, mesal view.

Tryssothele australis Chamberlin.

Fig. 8. Eyes, dorsal view.

Brachybothrium hageni Chamberlin.

Fig. 9. Right palpal organ of male, ectal view.



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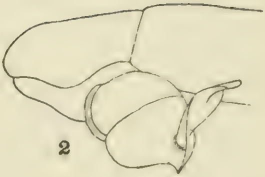

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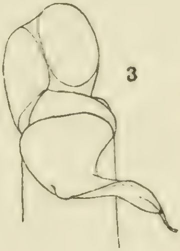

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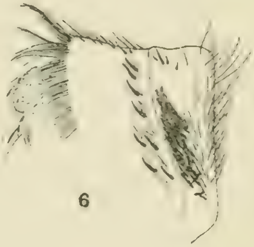

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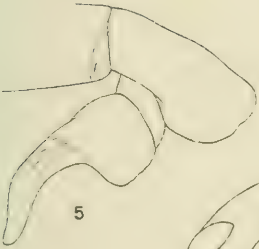

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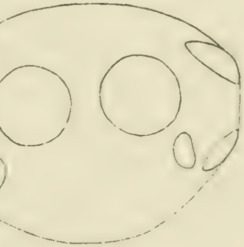

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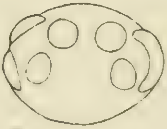

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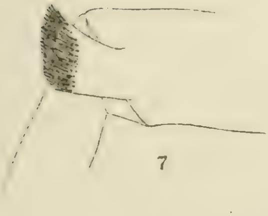

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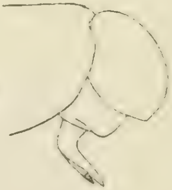

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NEW SPECIES OF APODAL FISHES.

By Alvin Seale.

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No. 4.— *New Species of Apodal Fishes.*

By Alvin Seale.

Recently while preparing a catalogue of the apodal fishes in the Museum of Comparative Zoölogy it was my privilege to critically study, measure, and tabulate the proportions of more than one thousand apodal fishes.

Among this series were 459 specimens of Anguilla from all parts of the known range of the Anguillidae. A study of the measurements of these eels revealed the fact that certain ones, M. C. Z. 9162 from the West Indies and M. C. Z. 22,440 (four specimens) from Panama, did not differ in the slightest degree from *Anguilla vulgaris* Turton of Europe, while all other American specimens were undoubted *Anguilla rostratus* Lesueur. This would indicate that the European and the American species of Anguilla intermingle, and perhaps interbreed on their southern range.

Descriptions of sixteen new species and one new genus are herewith presented.

MYRIDAE.

Muraenichthys labialis, sp. nov.

There are two specimens of Muraenichthys M. C. Z. 29,500 (A) and (B) from the Marshall Islands which were identified as *M. macropterus* Bleeker by Kendall and Goldsborough (Mem. M. C. Z., 1911, **26**, p. 245). But in Bleeker's type of *M. macropterus*, the jaws are of equal length, the anterior nostrils are not abnormally large, and the origin of the dorsal fin much nearer the anal than to the tip of the snout, while in these specimens, the lower jaw is only about half as long as the upper, the snout being prolonged, and the nostrils abnormally large resembling two large curved fangs hanging down from the upper lips. The origin of the dorsal is more than a third nearer the tip of the snout than to the origin of the anal.

A detailed description of the largest of these specimens M. C. Z. 29,500 (A), the type of *M. labialis*, is as follows:— Body slim, more or less worm-like; head rather large, pointed, the snout projecting; tail uniformly compressed from middle of body to tip; dorsal and anal confluent around tail; length of the head and trunk about one third less than length of tail; width of head almost equal to its depth; its length 11 in total; 3 in trunk. Mouth of moderate size; the upper jaw 3 in head; lower jaw 4.5 in head; the mouth closing fully. Teeth uniserial in jaws and vomer; sharp pointed and directed backwards in jaws; snout pointed 4 in head; anterior nostril a large cone-shaped tube directed downward on the upper lip just anterior to tip of lower jaw, posterior nostril a slit in upper lip mid-way between anterior nostril and eye; eye located on a line with angle of jaws; its length 2 in snout; gill-openings of moderate size lateral, being considerably smaller than the distance apart. No pectoral fin. Origin of dorsal about the length of head posterior to gill-openings; anal distinct. Total length 100 m.; length to origin of anal 40 m.; length of head 10 m.; length of origin of dorsal 20 m.

Type.— M. C. Z. 29,500. Arhno Atoll, Marshall Islands. ALBATROSS Tropical Pacific Expedition.

GARMANICHTHYS, gen. nov.

A genus of the Myridae, characterized by absence of pectorals, the high and distinct dorsal and anal with origin of dorsal near, but slightly posterior to gill-openings, the vomerine teeth in a widely separated series. Dorsal and anal united around tip of tail, nostrils on upper lip, the anterior in tubules the posterior an orifice opening downwards.

GARMANICHTHYS DENTATUS, sp. nov.

Body elongate-cylindrical compressed, head moderately pointed the jaws equal; tail gradually compressed from center of body; dorsal and anal fins continuous around tail.

Head 7.7 in total length; head in trunk 1.5. Total length 100 m.; length from tip of snout to origin of anal 31; length of tail 69, the tail therefore a little more than twice the length of head and trunk; head almost as wide as deep, a wide groove from occiput to tip of the rather wide snout. Mouth large, the lower jaw straight; distance from tip of snout to gape 2.3 in head; anterior nostril is a rather wide tube near tip of snout; posterior nostril a distinct orifice, opening downward in upper lip mid-way of length of upper jaw. Teeth all sharp pointed, conical. Maxillary teeth biserial, 35 in each row, the outer row of smaller teeth, the inner row of larger depressible teeth; premaxillary teeth biserial about ten in number; the inner row enlarged curved canines. Vomer with one large fang-like tooth in the median line anteriorly, plus ten widely separated rows of teeth on each side of the shaft of the vomer which extend from anterior of vomer to a line with angle of mouth; each of these rows consist of about twenty-three moderately sharp teeth which are hooked at tip and directed backwards; these teeth are larger than those of outer maxillary row. Mandibular teeth biserial on sides, triserial in front, the anterior row of several enlarged canines.

Snout 3.5 in head; eye with its posterior border on a line with angle of jaws; its length 2 in snout; gill-openings round orifices about size of eye and located above lateral line.

No pectorals; dorsal and anal fins distinct and united around tail. Origin of dorsal posterior to gill-openings by a distance about equal to snout.

Color in alcohol:— light yellowish brown thickly banded with reddish brown, these bands extending into the fins where they are very distinct; head and belly with large, round, reddish brown spots and blotches; a whitish band from just back of angle of jaws over the nuchal region, tip of snout somewhat lighter. Length 100 m.

Type.— M. C. Z. 28,095. Off Barbados, 69 fathoms.

OPHICHTHYIDAE.

Bascanichthys pusillus, sp. nov.

Body slim cylindrical, almost round in a middle section, head slightly larger owing to distention of the branchial chambers; width of head 1.2 in its depth; snout projecting, pointed. Tail tapering evenly from the posterior third of body, the tip bare; depth of body at anal pore 3.75 in head. The trunk and tail are about equal in length.

Length of head in trunk 8.50; in total length 14.8.

Mouth small, both the upper and lower jaw somewhat curved; mouth not closing fully; lower jaw almost a fourth shorter than the upper; length of upper jaw, from tip of snout to angle, 3.1 in head.

Maxillary teeth biserial, the outer row of about twenty sharp cylindrical teeth, directed backwards; inner row of about sixteen similar teeth. Premaxillary probably 3 in each side (in the type all but two of these teeth have been destroyed). Vomer with eighteen sharp teeth on the median line, these are distinctly biserial; mandibular in a single series, similar to maxillary teeth and directed backward.

Snout pointed, short, its length 7 in head; anterior nostril in tube on upper lip, even with extremity of lower jaw; posterior nostril on upper lip opening downward by a rounded aperture below the anterior margin of eye; eye small 2 in snout, its center about mid-way between tip of snout and angle of jaws.

Gill-openings rather wide slits below the median line, the width slightly greater than their distance apart on the ventral ends. Lateral line curved, the pores not prominent.

Pectoral fins very minute but present and rays can be seen with a lens; length about equal to eye; dorsal and anal well developed, terminating very near tip of the tail; origin of pectorals on nuchal region, far in front of gill-openings, its origin, in fact mid-way of the length of the head.

Color in alcohol:— uniform yellowish light brown, slightly darker above; fins uniform, but there is a shaded area along each side of the anal posteriorly on body. Length 450 m.

Total length 540 m.; head and trunk 250 m.; head 30 m.; to origin of dorsal 15 m.

Differs from *O. filaria* in the biserial maxillary and vomerine teeth.

Type.— M. C. Z. 25,147. Fiji Island. Museum Godeffroy, Hamburg.

QUASSIREMUS PRODUCTUS, sp. nov.

Cylindrical, elongate, the head conical, the snout projecting; upper jaw the longer; tail tapering uniformly from the anal pore, to an acute point, the tip naked; depth at anal pore 2.1 in head, tail about equal to trunk without head.

Head conical; its greatest width 1.1 in its greatest depth; it is contained 11.5 in total length and 5.4 in trunk.

Mouth moderate, closing completely; distance between tip of snout and angle of jaws 2.3 in head; maxillary teeth uniserial, of sixteen slightly curved conical teeth directly backwards. Premaxillary with two slightly large curved teeth near end of snout; vomer with a single series of graduated teeth extending back on the shaft. Mandibular teeth uniserial, of about fourteen conical teeth of moderate size.

Snout 4.9 in head; anterior nostril in tube slightly anterior to tip of lower jaw; posterior nostril a slit on under side of upper lip, on a line with anterior margin of eye; the eye is mid-way between tip of snout and angle of jaws, its length 1.7 in snout.

Gill-openings large, slit-like located low on the sides, their openings but little less than their distance apart. Lateral line is distinct, but pores not obvious. Dorsal and anal fins low but distinct; the pectoral is microscopic, easily overlooked, its length less than eye, represented by a small membraneous flap; origin of dorsal posterior to gill-opening by a distance contained 4 times into head. The dorsal and anal end very near the tip of the tail.

Color in alcohol:— body grayish with nineteen or twenty wide black bands over the back extending down to the lateral line; the bands as wide as the interspaces and alternating with large round black spots on the sides below the lateral line. A black bar over the head and through the eyes like a mask, a yellowish space in front and behind this mask; cheeks and top of head with large black spots ocellated with whitish; lower jaw with fine black specks, nuchal region with the first black bar. A few black dots on upper lip and on tip of snout; ventral surface and fins uniform.

Total length 595 m.; length to origin of anal fin 327 m.; to origin of dorsal 58 m.; length of head 53 m.

Type.— M. C. Z. 9150. Nassau, Bahamas, 10 November, 1861. J. D. Sargent.

QUASSIREMUS PARVIPINNA, sp. nov.

This species has distinct, but low dorsal and anal fins. The anterior nostril is in a tube near the end of the snout. Teeth all pointed; maxillary teeth uniserial, twenty-one, sharp, pointed, compressed, becoming smaller posteriorly; premaxillaries uniserial, consisting of five backwardly directed, conical, sharp, curved teeth, the largest of the upper jaw. Vomer with a cluster of four large sharp teeth anteriorly, plus a single series of fine small rounded teeth on the shaft. Lower jaw uniserial with about twenty-one curved conical teeth of moderate size. Origin of dorsal posterior to gill-openings. The pectoral fin is reduced to a small flap about equal to $\frac{1}{2}$ length of eye. Gill-openings lateral. Head in total length 12.1; head in trunk 5.

Origin of dorsal posterior to gill-openings by a distance equal to lower jaw, or by a distance equal to seven times the length of the pectorals; eye 2.5 in snout, its location mid-way between tip of snout and angle of jaws; angle of jaws mid-way between tip of snout and gill-openings; gill-openings rather wide, their location lateral. Caudal tip without fins, but with the dorsal end anal, coming very near to the tip. The pectoral is microscopic being one half the length of the eye.

Color in alcohol:— dull yellowish, the body everywhere blotched and spotted with dark brown, the spots on body usually larger than eye, some as large as length of snout; these show a decided tendency to form indistinct brown bands on the body in which the smaller dark spots show rather distinctly; snout and lower jaw black; head covered with spots smaller than the eye; some scattered spots on ventral surface; fins colored similar to body.

Total length 580 m.; head 42 m.; to anal pore 277 m.; to origin of dorsal 63 m.; length of pectoral 2.5 m.; length of eye 5 m.; width of gill-openings 6 m.; length of snout 10 m.

Related to *Q. crionthos* (Jordan & Bollman) but in this species the origin of the dorsal is but one length of the pectorals from tip of pectorals. The eye is nearer tip of snout in *Q. parvipinna,* the head is shorter, and the pectorals much shorter.

Type.— M. C. Z. 9205. Acapulco, Mexico, August, 1872. Hassler Expedition.

OPHICHTHYS SERPENTINUS, sp. nov.

Body elongate, cylindrical, almost round in the middle section, tapering somewhat to the small pointed head; the upper jaw projecting; tail tapering evenly from near the center to the acute bare tip; depth at anal pore 2.1 in head; tail almost twice the length of trunk, *i. e.* lacking only one half length of head of being twice as long as trunk.

Head small, conical; its width being 1.5 in height; its length 4.8 in trunk, and 15.3 in total length. Mouth rather small, the length from tip of snout to angle of jaws 2.75 in head; the mouth closing fully.

Maxillary teeth biserial, the outer row of about twenty-three small, rounded, pointed teeth; the inner row of about twenty larger, cylindrical, pointed teeth that are fixed and nondepressible; premaxillary teeth far forward, uniserial, three in each side. Vomer with six teeth anteriorly, arranged in an irregular double row, plus a single series of eight sharp graduated teeth on the shaft. Mandibular teeth in a single series of about twenty-one conical, sharp, pointed teeth; without large canines anteriorly. Snout 4.8 in head; pointed, the lower jaw the shorter, anterior nostril in a short wide tube situated on upper lip on a line with tip of lower jaw; posterior nostril a wide slit in the upper jaw, covered by a broad, rounded epidermal flap on the upper side of the openings, which is located anterior to eye and slightly nearer the eye than to the anterior nostril; eye is nearer angle of jaws by almost a third than to the tip of the snout, its length is 2.1 in snout. The gill-openings are wide slits below the median line, their length 1.5 in snout. They are slightly less than this distance apart on their ventral margins; lateral line distinct, the pores rather wide apart, about fifty-three between head and anal pore, several distinct pores on sides of head, upper jaw, and snout; these pores are not in white spots.

The pectoral fins are small but well developed, their length slightly greater than snout; dorsal and anal low but distinct, ending about length of snout from tip of tail; origin of dorsal posterior to gill-openings by a distance equal to head.

Color in alcohol: — uniform seal-brown.

Total length 495 m.; length to anal pore 192 m.; length of tail 303 m.; length of head 33 m.; length of origin of dorsal 63 m.

Type.— M. C. Z. 9200. Cape of Good Hope, July, 1860. L. Layard.

OPHICHTHYS UNISERIALIS, sp. nov.

Elongate cylindrical; the head pointed, conical, the upper jaw projecting; tail moderately compressed from the anal pore, and with a short acute point in the vertical plane; depth of anal 3 in head; length of head and trunk about equal to tail.

Head, somewhat compressed, rounded, and pointed; greatest width 1.50 into its greatest depth, length 11 in total length and 4.5 in trunk.

The mouth rather small, closing completely, the under jaw much the shorter; the distance between tip of snout and angle of jaws 3.25 in head. Maxillary teeth uniserial, eighteen in number, conical and pointed, of about equal size. Premaxillaries consisting of a clump of three conical backward directed teeth on each side, near the tip of snout and separated from the other teeth by an interspace. Vomerine teeth in a single series of twenty with the two anterior teeth rather small, those on the shaft large anteriorly but graduating posteriorly to very small teeth. Mandibular series uniserial except at tip, there being about twenty-one curved conical pointed teeth, moderately directed back in the jaw, besides two to three small curved teeth in the front.

Snout pointed; length 5.5 in head. Anterior nostril with a short wide tube just above tip of lower jaw; posterior nostril with a large fringed slit opening on upper lip; it also has an external opening in a small tube just posterior to the anterior nostril.

The center of eye is considerably nearer the angle of jaws than to tip of snout, length of eye 2.3 in snout. The pectoral, dorsal, and anal fins are distinctly developed, but the tip of the tail is bare. The pectorals are located at upper posterior margin of gill-openings, their length 4.7 in head; origin of the dorsal is posterior to the tip of pectorals by a distance equal to the eye; dorsal and anal very low, but wider near tip of tail where their terminal angle begins; they extend almost to tip of tail, the bare portion being but little longer than eye.

Color in alcohol:— drab, yellowish on belly and throat. The back and down to the lateral line has patches or mottlings of darker brown which are very irregular. The head has the mucous pores ending in black dots, four on the upper jaw, two behind the eye, and a row of four from above the eye to tip of snout; also a row of eight on under jaw extending posteriorly to gape.

Length 725 m.

Type.— M. C. Z. 25,957. China. J. D. Dana.

OPHICHTHYS EXILIS, sp. nov.

Body elongate, cylindrical, almost round in cross section; head conically pointed; upper jaw somewhat projecting. The tail is evenly compressed from the anal pore to the acute tip, which is bare; depth at anal pore 2.4 in head, the length of the tail a little more than twice the length of the trunk, without the head.

Head moderately compressed, its greatest width 1.5 in its greatest depth; its length 2.3 in trunk, and 8 in total length. Mouth of moderate size, the angle of jaws from tip of snout 2.5 in head; under jaw straight the mouth closing fully.

Teeth of maxillary biserial, twenty conical, pointed teeth in outer series and about sixteen in inner row. There are a few additional small teeth at angle of jaws in irregular formation; premaxillary uniserial consisting of three large canine-like teeth at the tip of upper jaw. Vomer has an irregular cluster of three large curved teeth on the median line anteriorly plus a single series extending back in a graduated manner on the shaft for twelve to fourteen sharp teeth. Lower jaw biserial, with about twenty-two conical, moderately pointed teeth of much larger size in the outer row; the inner row of smaller sharp teeth seventeen in number plus three large canine teeth at the snout 5.5 in head.

Anterior nostril in a tube on the upper lip just posterior to tip of lower jaw; posterior nostril opening a tube but little less in size than the anterior nostril and its location on upper lip about mid-way between eye and anterior nostril; eye 9.5 in head; 1.5 in snout; its center slightly nearer angle of jaws than to tip of snout (in smaller specimens almost equal).

Gill-openings very large, lateral, but almost entirely below the median line; their width equal to snout.

The fins are low but distinct, the origin of the dorsal is posterior to tip of the pectorals, by a distance equal to the eye (in small specimens this distance is equal to distance between eye and anterior nostril); pectorals 2.7 in head; dorsal and anal ending a distance from tip of tail about equal to eye.

Color uniform dark brown, lighter on chin and throat; small specimen lighter on under surface.

Pores distinct, about 45 on lateral line between anal pore and origin of dorsal; a distinct row of seventeen pores over nuchal region, and some less distinct, in snout and cheek.

	Type	*Cotype*
Total length	506 m.	423 m.
Length to anal pore	200	175
Length of head	60	55
Length to origin of dorsal	93	80
Length of trunk	136	115
Length of tail	310	253

Type.— M. C. Z. 28,401. Santiago, Chile, April 1, 1897. F. Latasti.

MURAENIDAE.

Muraena vagrans, sp. nov.

Body elongate, cylindrical, slightly compressed anteriorly, ending in the conical snout; lower jaw the longer. Posteriorly the body is evenly compressed from the anal fin to tip of tail; fins united around tip of tail; depth of body at anal about 2 in head; the tail longer than head in trunk by a distance less than length of head.

Head thick and strong its greatest width 1.4 in its depth; its length 2.75 in trunk (without head) and 8 in total length; mouth of moderate size and closing completely; the length from tip of snout to angle of jaws 2.2 in head; lower jaw projecting.

Teeth acute, compressed, biserial; maxillary with fourteen sharp teeth in outer row and seven larger curved, conical, depressible teeth on inner row; premaxillary with an outer row of nine or ten small teeth and an inner row of five large canines. Vomer with three large teeth anteriorly plus two series of short rounded teeth on the shaft, each series of eight teeth; mandibular teeth in a single row of twenty-one sides of jaw, plus two series in the front of eight teeth.

Snout rather short and high, its length 4.7 in head, its height 1.5 in its length; anterior nostril in a short tube above the upper lip near tip of snout; posterior nostril in a tube fully as large and located on a line with anterior margin of eye; eye slightly nearer angle of jaws than to tip of snout, its length 3 in snout. Gill-openings small, about equal to eye, the aperture distinctly tubular and located below the lateral line.

No pectoral fin, dorsal and anal distinct, and united around tail; origin of dorsal on nuchal region, far in advance of gill-openings.

Color in alcohol: — uniform black.

Total length 555 mm.; length to anal 260 mm.; length of tail 295 mm.; head 70 mm.

Type.— M. C. Z. 2532 B. South America?

Muraena viridipinna, sp. nov.

Body cylindrical, elongate, compressed; head conical, the lower jaw slightly the longer; tail evenly compressed from anal pore;

depth at anal pore 2.5 in head; the tail is but little longer than head and trunk.

Head moderately pointed, its length in total 9.3; in trunk 4; mouth rather wide, the lower jaw somewhat curved, so that probably in life, the jaws do not close completely; length from tip of snout to angle of jaws 2.1 in head.

Teeth in maxillary biserial, the outer row of twenty sharp compressed teeth directed backwards, the inner row of four larger conical teeth; premaxillary with six large canines plus four or five small teeth pushing up among them. Vomer with large canines anteriorly, plus a single series of six short, thick, but pointed teeth on the shaft; mandible with teeth in a single series of fourteen acute teeth on sides, plus two interior canines forming the inner series in front. Snout at its posterior base about as wide as high; its length 5.5 in head.

Anterior nostrils in short tube near tip of snout; these are scarcely equal to length of pupil; posterior nostrils with a short tube or rim, distinct, but might be easily overlooked without a lens. The nostril is located above the anterior margin of eye. The eye is 1.5 in snout and is located mid-way between angle of jaws and tip of snout.

Lateral line and mucous pores not distinct.

Gill-openings slightly larger than eye and located on middle of sides.

No pectoral fin; dorsal and anal fins distinct but not especially elevated, they meet around the end of tail; origin of dorsal directly above the gill-openings.

Color in alcohol:— uniform seal-brown, fins darker, without any white margins; black at angle of jaws and at gill-openings; the fins when the specimen was first received, according to a note, were green.

Total length 211 m.; to anal pore 93 m.; length of tail 118 m.; length of head 23 m.

Type.— M. C. Z. 6146. Mauritius. Nicholas Pike.

MAURAENA ACUTIS, sp. nov.

Body elongate, cylindrical, somewhat compressed, the head rather sharp pointed, the jaws of equal length, tail evenly compressed from the anal pore to tip; dorsal and anal confluent. The length of the head and trunk slightly greater than tail; head 2.75 in trunk and 7 into total length. Mouth of moderate size and closing completely; the under jaw being strongly curved; length from tip of snout to angle of jaws 3 in head.

Teeth of maxillary biserial, the outer row of fourteen rather short, pointed teeth; the inner row of six or seven large conical teeth the pointed tips directed backwards; premaxillary with six or seven large, pointed teeth set in a semicircle. Vomer with three large depressible teeth anteriorly plus a biserial series on the shaft; each row consisting of about seven short, rounded teeth; lower jaw with twenty-two sharp teeth on sides plus three large anterior canines on each side.

Snout rather high and pointed, its height a third more than its width; length of snout 5.5 in head; anterior nostrils in tubes near tip of snout; posterior nostrils also tubular, but shorter, located directly above the anterior margin of eye. Gill-openings of moderate size. Eye nearer to angle of jaws than to tip of snout; its length 1.75 in snout.

No pectoral fin; dorsal and anal well developed and meeting around tip of tail; origin of dorsal on nape considerably in advance of gill-openings.

Color in alcohol:— cherry-brown with few scattered white specks, size of a pin-point, a few on anterior of body slightly larger, as large as head of pin, but none so large as pupil of eye.

Total length 281 mm.; length to anal pore 150 mm.; length of tail 130 mm.; length of head 40 mm.

Type.— M. C. Z. 3960. Pearl Island, Gulf of Panama. Alexander Agassiz.

GYMNOTHORAX PIKEI, sp. nov.[1]

Body cylindrical, elongate; head moderately pointed, the jaws equal; tail evenly compressed from the anal pore, its length slightly greater than head and trunk; depth at anal pore 2.50 in head.

Head 7.5 in total length; 2.7 in trunk. Mouth rather large, not closing completely; the under jaw being curved; length from tip of snout to angle of jaws 2.1 in head.

Teeth uniserial, the maxillary with about twelve acute teeth; premaxillary teeth five on each side. Vomer with two large fange-like, depressible teeth anteriorly, plus a single row of fourteen sharp teeth on the shaft; mandibular teeth about twenty-one; some of the teeth serrate. (The mouth has been badly broken and many teeth lost). Snout 4.5 in head, its width at center greater than its depth; anterior nostrils in small tubes near end of snout; posterior nostril without tubes and located above the anterior portion of the eye. The eye is about mid-way between tip of snout and angle of jaw.

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[1] In 1882 Dr. Franz Steindachner studied the fishes in the Museum of Comparative Zoölogy. During that time he labeled three jars *G. pikei* Steind.; *G. insignis* Steind.; *G. elegans* Steind. So far as I can ascertain no descriptions were ever published; as these seem to be valid new species I have described them, using the names of that eminent ichthyologist.

Gill-openings the size of eye, and located on middle of sides.

No pectoral fin. Anal and dorsal distinct, and uniting around tip of tail; origin of dorsal anterior to gill-openings at the beginning of nuchal region.

Color grayish white, with narrow black bands, about as wide as eye and much less than interspaces; fifteen of these on head and trunk. There seemed to have been about twenty-one additional bands on the tail as they show distinctly in both the anal and dorsal fins, but on the sides of the tail, the lower portion of these bands seems somewhat broken up into spots.

The anterior band is on tip of snout, the second through the eye; the third through the angle of jaws; there are two more distinct bands between the angle of mouth and the gill-openings. The gill-openings fall mid-way between the dark bands and are located in a distinct brown spot. Fins colored like body.

Total length 905 m.; length to anal pore 430 m.; length of tail 475 m.; length of head 120 m.

Type.—M. C. Z. 6145. Mauritius. Nicholas Pike.

GYMNOTHORAX ELEGANS, sp. nov.

Body elongate, cylindrical, compressed; head moderately pointed, mouth large, the lower jaw slightly the longer; tail evenly compressed from the anal pore 1.8 in head. The head 9.60; into trunk 3.1.

Mouth rather large; length from tip of snout to angle of jaws 2.2; jaws not closing fully. Teeth uniserial; maxillary with eleven acute, compressed teeth which decrease in size posteriorly; premaxillary with six sharp teeth. Vomer with one large depressible fange anteriorly, plus a single series of three small short teeth on the shaft; mandibular teeth twenty on each side acute, compressed, becoming smaller posteriorly. Snout rather short and high, its length 5.1 in head, its depth at eye about equal to its width; anterior nostrils in tubes about half as long as eye; posterior nostril without tube and located on a line above anterior margin of eye; the eye is small 2.1 in snout and located somewhat nearer tip of snout than to angle of mouth. Gill-opening about one third larger than eye and located on middle of sides.

No pectoral fins, but dorsal and anal are distinct, and unite around tail; origin of the dorsal on the nape of head far in advance of gill-openings.

Color in alcohol:— yellowish brown the anterior two thirds of body with narrow lines of dark brown which mark off the ground color in round or hexagonal yellowish white spots; these are small on the head, but from the gill-openings posteriorly they are chiefly larger than eye and of much greater width than the dark brown wavy bands on the posterior third of the body; these wavy bands are almost equal to the interspaces and extend far into the dorsal, but not into the anal; there is a dark stripe along the base of anal and extending more or less interruptedly across the belly to chin; otherwise the anal is white; the gill-openings are black.

Total length 645 m.; length to anal pore 275 m.; length of tail 370 m.; length of head 67 m.

This specimen somewhat resembles *G. insignis*, but has a larger mouth, longer snout, and is differently marked.

Type.— M. C. Z. 5954. Mauritius. Nicholas Pike.

GYMNOTHORAX DORSALIS, sp. nov.

Body elongate, compressed, cylindrical, the snout not particularly sharp pointed, the tail even compressed on the lateral plane in the posterior third of length, but not so strongly compressed on the vertical plane; depth at anal pore 3.50 in head; length of tail only one half length of head greater than head and trunk.

Head 8.2 in total length; 2.8 in trunk without head; width of head but little more than its depth; mouth rather large, closing completely; length from tip of snout to angle of mouth 3 in head, the upper jaw just a trifle the longer.

Teeth of maxillary biserial, sharp, compressed, conical, about twenty in outer series and four large depressible canines in the inner maxillary series; premaxillary uniserial, of seven strong teeth; inner with three large depressible canines anteriorly, plus a single series of three strong sharp teeth on the shift; mandibular teeth in a single row of twenty-four on the sides, plus an inner row anteriorly of four canines.

Snout short and wide, its length 2.5 in upper jaw, its width 3 into same distance; anterior nostril a distinct tube at tip of snout, posterior nostril a round opening without rim or tube, on a line with end above anterior margin of eye. The eye is distinctly nearer the tip of snout than to angle of jaws; its length 2.2 in snout; gill-openings round considerably larger than eye, and located below the lateral line.

No pectoral fin; dorsal and anal distinct and united around tip of tail. The dorsal is very low anteriorly and hidden in the skin, but dissection shows its origin to be anterior to gill-openings; anal fin is also very low.

Color in alcohol:— uniform yellowish brown, the dorsal and anal fins posterior are distinctly margined with black.

Type length 822 mm. Head and trunk 390; head 100; tail 432. Cotype (A) length 750; head and trunk 320; tail 430; head 80.

Type.— M. C. Z. 31,060 (A). *Cotype.*— M. C. Z. 31,061. Hong Kong.

GYMNOTHORAX INSIGNIS, sp. nov.

Body cylindrical, elongate, slightly compressed; head not strongly pointed, jaws equal; tail evenly compressed from anal pore; tail but little longer than head and trunk.

Head 8.9 in total length; 3.4 in trunk without head; lower jaw somewhat curved probably the mouth not closing fully; length from tip of snout to angle of jaws 2.2 in head.

Teeth uniserial; twelve compressed sharp teeth in maxillary, these teeth becoming smaller posteriorly; premaxillary with six sharp teeth; inner with one large tooth anteriorly (probably two as there is a tooth-scar) plus a single row of but two pointed teeth on the shaft. Mandible with twenty-two sharp compressed teeth which graduate smaller posteriorly; snout short 5.5 in head, its depth at eye equal to its length, its width at its posterior portion less than its depth; anterior nostrils in short tube, much less than eye; posterior nostril not in tube and located above anterior portion of eye.

The eye small 2.75 in snout, and located considerably nearer to tip of snout than to angle of jaws.

Gill-openings large, more than twice as large as eye and located on middle of sides. No pectoral fin, dorsal and anal distinct and united around tail; origin of dorsal on nuchal region.

Color in alcohol:— pale yellowish brown anteriorly, gradually becoming a darker brown posteriorly. Fins and entire body covered with round white spots, which are very fine, the size of a pin-head on snout and very close together, but gradually becoming larger and farther apart posteriorly so that over the tail they are as large as the eye and the interspace between them is usually twice the width of the spot. The gill-opening is black, no black at angle of jaws.

Total length 775 m.; length to anal pore 375 m.; length of tail 400 m.; head 85 m.

Type.— M. C. Z. 5912. Mauritius. Nicholas Pike.

SCUTICARIA UNICOLOR, sp. nov.

Body elongate, cylindrical, compressed, anterior portion of head conical; jaws equal. The tail not tapering gradually from the middle of body, but is rather abruptly compressed in the last fourth of the length. No fins; depth at anal pore 2.5 in head; the tail but little more than one third the total length; head 13.8 in length; 8 in trunk.

Mouth of moderate size, closing fully; length from tip of snout to angle of jaws 2.7 in head. Teeth of about uniform size; sharp, pointed, conical, biserial in jaws, and uniserial on vomer. Maxillary with thirteen teeth in outer series and ten in inner series. The inner series depressible. Premaxillary teeth five in outer series and three in inner. Vomer with two large depressible teeth anteriorly plus five sharp, fixed teeth in the shaft; mandible with twenty in outer series and seven in inner; snout short, six in head; nostrils all tubular, the posterior tubes about one third shorter than the anterior ones. The eye distinctly nearer to tip of snout than to angle of jaws; its width 2 in snout. Gill-openings small, about equal to eye, located above the lateral line. Fins none.

Color in alcohol: — uniform yellowish brown without markings.

Type length 620 m.; length to anal pore 405 m.; length of head 45 m.; length of tail 215 m. Cotype (A) length 552 m.; length to anal pore 370 m.; length of tail 182 m.; length of head 40 m.

Type.— M. C. Z. 9188. *Cotype.*— M. C. Z. 9188 (A). Society Islands. Andrew Garrett.

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NEW FOSSORIAL HYMENOPTERA.

By Nathan Banks.

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No. 5.— *New Fossorial Hymenoptera.*

By Nathan Banks.

The following pages contain descriptions of some new fossorial Hymenoptera in the collections of the Museum, together with a table to the subgenera of Psammochares and a synopsis of the genus Elis. Most of the new species are from the western United States, and several were collected in Oregon and Washington during the Northern Transcontinental Survey, in 1882.

PSAMMOCHARIDAE.

Aporinellus completus, sp. nov.

Type.— M. C. Z. 10,004. Washington: Lone Tree, Yakima River, 30 June, 1882; Thorp, Kittitas Valley, 10 July, 1882. Samuel Henshaw. Two specimens.

♀ Very similar in structure to *A. fasciatus*, but the body (except apical two segments of the abdomen) is sericeous. The third and fourth segment of antennae are a little shorter than in *A. fasciatus*, but of about the same proportion to vertex width. The femora and tibia are sericeous, the hind tibia with the inner spur two thirds as long as the basitarsus. The wings are dark at apex, and venation as in *A. fasciatus*. The male is very slender, sericeous, the abdomen black, the basal segment and apical margin to next three segments sericeous; the apical segment is black (not sericeous as in *A. fasciatus*).

Aporinellus medianus, sp. nov.

Type.— M. C. Z. 10,005. Calif.: El Cajon, 1 May. E. P. Van Duzee; Los Angeles, May. M. C. Van Duzee. Two specimens.

♀ Black; clypeus and basal part of the face white pollinose, the white extending part way up inner orbits, posterior orbits narrowly white pollinose, as also the basal third of the mandibles, middle third reddish, apical third black. Clypeus truncate in front; face as wide above as below, an impressed line from anterior ocellus to the antennae; second plus third joint of antenna hardly equal to vertex width, third joint much longer than the fourth; vertex from in front nearly straight across; posterior ocelli closer to eyes than to each other. Pronotum with the posterior margin broadly rounded; metanotum sloping, with median groove, posterior angles acute, not silvery. The abdomen shows a large white pollinose spot in middle on posterior edge of first and second segment, barely showing on the third; last segment with few long hairs. Legs with the outer side of tibiae faintly gray pollinose; tarsi I with comb of six long spines as usual; inner spur of hind tibia two thirds of the metatarsus. Wings deep black on the apical fourth, rest much paler; marginal cell very short, more than twice its length from the apex (in one specimen the second submarginal is divided in both wings). Length 8 mm.

ALLOCHARES, gen. nov.

Type species.— *A. bruesi* Banks.

Wing with pocket in base of second discoidal cell; spiracles scarcely their length from base of the metanotum; labrum not visible; pronotum rather long, but convex; a distinct malar space; metanotum produced each side behind in a tooth; legs practically destitute of spines; the tarsal claws rather short, nearly straight, thickened below to near the slender tip, from the tip of the thickened part extends a hair toward the tip of the claw; third joint of antennae of female much longer than the first; clypeus rounded below. Related, I think, by shape of metanotum and the nature of tarsal claws to Aporinellus, but distinct by absence of spines on legs.

ALLOCHARES BRUESI, sp. nov.

Type.— M. C. Z. 10,006. Texas: Austin. C. T. Brues. Two specimens.

Blue-black, the thorax and abdomen especially showing the blue; antennae, legs, and wings black. Head swollen above the base of the antennae then sloping to vertex; face plainly longer than broad, slightly broader in the middle than above or below, vertex nearly straight across; clypeus rounded below, clypeal suture slightly sinuate each side, a median groove from antennae toward anterior ocellus, ocelli small, far apart, the lateral ones much nearer to eyes than to each other; antennae slender, but not very long, the third joint plainly longer than the fourth; pronotum moderately long, almost angulate behind; metanotum short, bilobed at base, the posterior face forming a large pit, the lateral angles projecting behind into a stout tooth. Abdomen slightly compressed; entire body devoid of hairs. Legs moderately slender, without spines, except minute ones at tips of tarsal joints below, inner spur of hind tibia about two thirds of the basitarsus. Wings uniformally blackish; basal vein interstitial, marginal cell acute, second submarginal slightly longer than broad, third barely longer, slightly narrowed above, first recurrent near end of cell, second near middle; in hind wings the cubital fork arises beyond the cell. Length 8 to 9.5 mm.

PLANICEPS COMPRESSUS, sp. nov.

Type.— M. C. Z. 10,007. Va.: Alexandria Co., near Court House. Nathan Banks. One specimen.

♀ Similar in structure to *P. niger*, but larger, more plainly clothed throughout with dense russety pollen, and the abdomen beyond middle much more compressed. Venation about the same, but the second submarginal cell is hardly as long, and the second discoidal also shorter. Wings deep black throughout. The antennae are longer, the third, fourth, fifth, etc. joints being plainly proportionally longer than those joints in *P. niger*. The front margin of the clypeus is truncate, almost slightly concave (faintly convex in *P. niger*). Length 14 mm.

PLANICEPS HIRSUTUS, sp. nov.

Type.— M. C. Z. 10,008. Calif.: Pasadena, August. One specimen.

♀ Deep bluish, iridescent, rather purplish at tip of abdomen, head greenish in front; antennae and legs mostly black; wings black, deeply purplish iridescent. Head flat, more narrow than in *P. niger*, eyes reaching up to vertex, from in front vertex is straight across or almost concave; ocelli small; antennae short, second and third joints together not as long as the first; clypeal margin slightly rounded. Pronotum long, plainly longer than broad, rest of thorax and abdomen slender; metanotum without median groove. Legs stout, front pair short, hind tibia with inner spur equal to one half the basitarsus. Wings rather short; basal vein strongly convex, interstitial with cubital cross-vein; third discoidal cell very short, second recurrent ending a little beyond second submarginal cell.

latter a little longer than broad; in hind wings cubital ends a long way before the fork of median. Thorax, abdomen, and legs with long black hair, especially noticeable on the metanotum, femora, and coxae beneath; front with very short hair. Tibial spines numerous and stout. Length 11 mm.

PLANICEPS ASSIMILIS, sp. nov.

Type.— M. C. Z. 10,009. Brit. Columbia: Penicton, August. J. B. Wallis. One specimen.

♀ Related to *P. hirsutus*, but differs in having the pronotum fully as broad as long. Black, with blue or violaceous reflection; the antennae very short, the third joint as short as in *P. hirsutus;* face with erect bristles, vertex straight across; pronotum fully as broad as long, plainly angulate behind in middle, the metanotum with appearance of a median line which, however, is not present, abdomen moderately slender, subcompressed, hairy near tip, mid and hind tibia with stout spines as in *P. hirsutus*, the inner spur of hind tibia one half the length of basitarsus; thorax with hair plainly shorter than in *P. hirsutus* the legs also less hairy than in that species, but more hairy than most species of the genus. Venation as in *P. hirsutus*, except that the second submarginal and especially the second discoidal cells are longer than in *P. hirsutus*. Length, 11 mm.

PEDINASPIS ANOMALA, sp. nov.

Type.— M. C. Z. 10,010. Texas: Coryell Co. G. Birkmann. One specimen.

♀ Black, with purple reflections on body, wings a uniform black. In general very similar to *P. vicina* Cress. The antennae shorter than in that species, the ocelli smaller and farther apart, the lower margin of clypeus truncate, almost concave, metanotum short, the posterior surface more declivous than in *P. vicina;* legs with spines rather smaller than in *P. vicina*, inner spur of hind tibia nearly one half the length of the basitarsus, all femora with fine, short hairs. Venation in the single specimen may be abnormal in having but two submarginal cells, the second long and receiving both recurrent veins; the third discoidal cell very short, more so than in *P. vicina*, and the basal vein at base of first discoidal cell is strongly bowed basally, and is interstitial with the cubital cross-vein. In *P. vicina* the basal vein shows an even curve. Length, 15 mm.

The two cells indicate a Planiceps, but the general structure is plainly that of a Pedinaspis, and Planiceps should be limited to species in which the second recurrent vein ends beyond the second submarginal cell.

PRIOCNEMUS.

Priocnemus nebulosus and *P. fulgifrons* differ from other species of the genus in having a stigma which is paler in the center than on the edges; only females are known. Taken at the same places and times with these are *Ageniella pulchrina* and *A. agilis*, all males. In these also the stigma is paler in the center than on the edges. Therefore I am inclined to consider *A. pulchrina* as the male of *P. nebulosus*, and *A. agilis* as the male of *P. fulgifrons*. It is possible therefore that other species of Ageniella of which the male only is known may belong to species of Priocnemus of which only the female is known, there are several such in each genus, but I am at present unable to present evidence in any particular case; moreover there are Ageniellas similar to the others in which both sexes are known, and several species known only in the female.

CRYPTOCHEILUS RUGOSUS, sp. nov.

Type.— M. C. Z. 10,011. Washington: Wawawai, June. W. M. Mann; Arizona: Oak Creek Canon, 6,000 ft. F. H. Snow. Two specimens.

♀ Black; black antennae, reddish yellow wings, slightly margined with black at tips. Metanotum coarsely transversely wrinkled above on the basal half, not on the posterior slope, densely hairy. Abdomen shining, hairy, especially at tip, segments slightly constricted at ends. Head densely hairy, clypeus truncate; anterior ocellus scarcely diameter from the laterals; vertex convex; antennae short, stout, second with third joint not nearly as long as vertex width; pronotum arcuate behind. Legs stout, spiny, and hairy; all femora hairy above and below, hind tibiae with many short bristles, nearly obscuring the teeth; inner spur not one half of the basitarsus. In hind wings the cubitus is interstitial with fork of median; in fore wings the marginal cell is hardly acute at tip, first recurrent at middle of second submarginal; second recurrent barely sinuate, meeting the third submarginal at the middle, latter extending much beyond the marginal. Length, 16 to 20 mm.

CRYPTOCHEILUS AUSTRINUS, sp. nov.

Type.— M. C. Z. 10,012. Texas. G. W. Belfrage. Coll. Peabody Academy Science, Salem. One specimen.

♀ Black; black antennae, yellowish wings darkened at tip, sparsely hairy, clypeus truncate. Antennae slender, second and third fully distance from eye to eye, eyes not reaching the vertex, latter convex, ocelli close together, pronotum almost angulate behind, metanotum coarsely transversely wrinkled above on basal part, sparsely long haired. All femora slender and smooth, the hind tibiae strongly serrate, the inner spur hardly one third of the basitarsus. In the hind wings the cubitus is interstitial with fork of median; in fore wings the marginal cell is slightly pointed, first recurrent ends at apical fourth of the second submarginal, the second recurrent strongly bent out near middle and ending before middle of the third submarginal, the latter extending plainly beyond the marginal. Length, 20 mm.

Cryptocheilus austrinus has a great resemblance to *C. texanus*, but the strongly wrinkled metanotum will distinguish it.

CRYPTOCHEILUS INAEQUALIS, sp. nov.

Type.— M. C. Z. 10,013. Washington: Camp Umatilla, 27 June, 1882. Samuel Henshaw. One specimen.

♂ Similar to *C. heiligbrodti.* Black with reddish yellow wings, slightly tipped with dark; as in male *C. heiligbrodti* there is a short pale line on inner orbits opposite antennae. Entire body densely black haired, front femur with short hairs below, and hind femur rather hairy on the basal part above, and very few below; metanotum densely hairy, not wrinkled, with median groove, most distinct behind. Wings with venation similar to *C. heiligbrodti;* first recurrent at middle of second submarginal cell; second recurrent little curved, and meets third submarginal cell a little before middle; the marginal cell is broad at tip, and the third submarginal reaches a long way beyond it. Length, 17 mm.

MYGNIMIA HESPERINA, sp. nov.

Type.— M. C. Z. 10,014. Calif.: Stanford University. R. W. Doane; San Diego. E. P. Van Duzee; N. Mex.: Jemez Mts. John Woodgate. Four specimens.

♀ and ♂. In general very similar to *M. ustulata.* Black; black antennae, reddish wings, more red than in *M. ustulata*, with definite black tips. Metanotum densely haired, and transversely wrinkled. Legs spined as in that species; third and fourth antennal joints a little shorter than in *M. ustulata*. Wings with venation much like *M. ustulata*, but the second recurrent is practically straight and ends nearly at middle of the third submarginal cell; the first recurrent ends plainly before end of second submarginal cell; the third submarginal extends rather further beyond the marginal than in *M. ustulata*. Length, 15 to 20 mm.

MYGNIMIA USTULATA Dalbom.

Occurs in Texas, Kansas, and Arizona. Wings are black at base as well as at tips; the second recurrent vein sinuate, the marginal cell broad at tip, the metanotum hairy and transversely wrinkled above; the first recurrent ends practically at end of the second submarginal cell.

POMPILOIDES SUBCYLINDRICUS, sp. nov.

Type.— M. C. Z. 10,015. Va.: Falls Church, July, August. Nathan Banks. Thirty-two specimens.

Similar to *P. cylindricus*, but the pronotum in both sexes is arcuate behind.

Black; in female the wings very dark, male with lighter wings, dark at tips.

♀ Antennae rather shorter than in *P. cylindricus*, the third joint, however, elongate; hind legs also shorter than in that species. Face about as in that species; pronotum broadly arcuate behind; metanotum with median groove rather deeper than in *P. cylindricus*. Abdomen hairy at tip and on apex of ventral segments; venation as in *P. cylindricus;* third submarginal cell triangular or short petiolate.

♂ Similar to ♀, but very slender; the lower face and about base of antennae, part of pronotum, and much of the pleura silvery pubescent; venter without brushes.

Size as in *P. cylindricus*.

SOPHROPOMPILUS TUMIFRONS, sp. nov.

Type.— M. C. Z. 10,016. Calif.: San Diego Co., 14 June. E. P. Van Duzee. One specimen.

♂ Blue-black, densely hairy; clypeus rounded below; antennae short, third joint shorter than fourth, face above antennae swollen and sloping to vertex, densely long-haired, vertex, seen from in front, almost conically produced in middle between the ocelli, more prominent than in other species; pronotum longer than usual, arcuate behind, densely long-haired; metanotum low and rather long, hairy, with a polished median line; abdomen rather depressed, hairy all over; legs moderately short, and strongly spined, all coxae and femora hairy; inner spur of the hind tibia nearly two thirds of basitarsus. Wings black, basal vein interstitial with the transverse, second submarginal cell plainly longer than broad, receiving the first recurrent vein at tip, third submarginal cell about as long as the second, narrowed above, receiving the second recurrent vein at middle; marginal cell rather long, acute; in the hind wings the cubital fork interstitial with end of the cell. Length, 10 mm.

Differs from allies in more raised area at ocelli, and the longer pronotum.

ANOPLIUS BOLLI, sp. nov.

Type.— M. C. Z. 10,017. Texas: Dallas. Jacob Boll. One specimen.

♂ Black, densely silvery pubescent, and white haired on head and posterior part of metanotum; posterior margin of pronotum white; silvery patch each side of the scutellum, postscutellum silvery above and silvery band across apex of metanotum; abdomen with silvery band on bases of first, second, and third segments, the fourth with a large oblique patch each side, the fifth and sixth wholly silvery above. In structure and proportions closely similar to A. (*Aphiloctenus*) *virginiensis*. The spines on the legs are rather longer, the inner spur of hind tibia is shorter, being less than three fourths of the basitarsus; wings and venation much like *A. virginiensis*, but the third submarginal is rather longer. The fourth ventral segment of the male has a dense tuft of black hair, much heavier than in *A. virginiensis*, and few hairs on the other segments. Length, 11 mm.

PSAMMOCHARES SCUDDERI, sp. nov.

Type.— M. C. Z. 10,018. Canada. Winnipeg: S. H. Scudder. One specimen.

♀ Small, black, with erect, long hair on head, thorax, abdomen above and below, and on coxae, femora, tibiae and even one or two on the tarsi; those on tibia nearly as long as width of the joint. Wings blackish, but darker toward tip. Head very broad, clypeus broadly rounded below, impressed line on front, vertex convex, lateral ocelli much closer to each other than to the eyes. Antennae short, basal joint with a row of hairs on the outer edge; third and fourth joints subequal, neither longer than first joint. Pronotum broadly arcuate behind, but not long; metanotum short, no definite groove; abdomen shining, not very slender. Tibiae and tarsi strongly spinose, hind tibia with inner spur about two thirds of the basitarsus, claws with median tooth. Wings with rather short marginal cell, third submarginal larger than the second, narrowed above, each recurrent vein is received a little beyond middle of cell. Length, 6.5 mm.

Reminds one of *P. hyacinthinus*, but the densely, long-haired body is quite unique.

PSAMMOCHARES DIFFICILIS, sp. nov.

Type.— M. C. Z. 10,019. Va.: Falls Church, 5, 17 September. Nathan Banks. Two specimens.

♀ Black throughout, or with a slight violaceous reflection. Front and vertex with long, black hairs; antennae slender, third joint much longer than the fourth, second, and third together about equal to vertex width, basal joint without long hair below; vertex (from front view) nearly straight across; lateral ocelli as close to eyes as to each other; clypeus truncate; pronotum angulate behind, but not strongly so; metanotum with erect, black hair, no definite median groove. Coxae I black-haired; tarsus I with comb of long spines, but that at tip of the second joint is shorter, and not nearly as long as the third joint; hind tibiae with spines about one half the diameter of the joint, inner spur more than one half the basitarsus. Wings deep black, third cell nearly triangular, marginal cell short, basal veins interstitial. Length, 15 mm.

Related to *P. astur*, but larger, the apical comb-spine of second joint much shorter, the third cell and marginal cell also shorter.

PSAMMOCHARES CLEORA, sp. nov.

Type.— M. C. Z. 10,020. Calif.: Los Angeles, 3 May. M. C. Van Duzee. Two specimens.

♀ Moderate size; deep black. Clypeus plainly emarginate in middle, clypeus, face, vertex, basal joint of antennae, prothorax, coxae I, and metanotum with long black hair, fewer and shorter hairs elsewhere, but tip of abdomen bristly, and scattered, long hairs on venter. Antennae slender, third joint much longer than first; fourth shorter, but longer than first; a deeply impressed line from antennae to ocelli; hind ocelli about as close to eyes as to each other; vertex straight across, face barely narrower at upper than at lower end of eyes. Pronotum broadly arcuate behind. Metanotum with a median groove. Abdomen of moderate length, slightly depressed on basal segments. Legs slender, a few short hairs on femora of front and mid legs; tarsus of front legs with a comb of long curved spines, four on outer side of basal joint. Spur on hind tibia little more than one half as long as basitarsus, spines on hind tibia not as long as width of the joint. Wings deep black; second submarginal cell about one fourth longer than broad, third shorter, subtriangular, less than one half as long above as below, receiving second recurrent vein at middle, this recurrent arising much beyond the middle of apical cell; basal veins interstitial. Length, 12 mm.

PSAMMOCHARES PHILADELPHICUS var. FLORIDENSIS, var. nov.

Type.— M. C. Z. 10,021. Fla.: Gulfport, September. A. G. Reynolds. One specimen.

♀ Deep blue; the wings blue-black, beautifully iridescent; structure similar to *P. philadelphicus.* The clypeal margin perhaps not quite as deeply emarginate as in the typical form, and the vertex between the eyes a little broader, and the third antennal joint rather longer; the ventral segments less hairy, and the minute spines on the upper surface of the femora are more numerous, especially on the front femora.

More distinct from the type than the variety *P. p. sericatus*, and possibly a distinct species.

PSAMMOCHARES.

I prefer, for the present, to keep this genus in its broad sense and make the following subdivisions of it which may be considered as of subgeneric value. This arrangement is based on the female, but in some cases males can also be placed in it.

1. Third joint of antennae of female barely if at all longer than the first joint; spines under last joint of hind tarsi very weak; clypeus not emarginate; often bluish species 2
   Third joint of antennae plainly longer than the first 4
2. No comb on front tarsi; legs very hairy . . . . *Chalcochares.*
   A comb to front tarsi 3
3. Metanotum hairy . . . . *Sophropompilus.*
   Metanotum not hairy . . . . *Nannopompilus.*
4. Third abdominal segment hairy above, as well as rest of body and femora. *Arachnophila.*
   Third segment not hairy above 5
5. No spines under last joint of hind nor front tarsi; clypeus not emarginate; third submarginal cell not petiolate 6
   Spines distinct under last joint of hind tarsi; no malar space 9
6. A distinct malar space between eye and base of mandibles 7
   No distinct malar space 8
7. Comb to front tarsi; metanotum oblique; small, delicate species. *Agenoideus.*
   No comb to tarsi; metanotum flat at base; larger, black species. *Allocyphonyx.*
8. Fairly large species; metanotum hairy in the female at least; abdomen elongate . . . . *Sericopompilus.*
   Small species; metanotum not hairy above; abdomen in female not so elongate . . . . *Gymnochares.*
9. Clypeus of female strongly emarginate in middle; front femora with minute spines above 10
   Clypeus not plainly emarginate 11
10. Pronotum arcuate behind; metanotum very hairy above. *Lophopompilus.*
    Pronotum angulate behind; metanotum scarcely hairy above. *Notiochares.*
11. A strong comb on front tarsi; metanotum hairy above . . *Psammochares.*
    No comb to front tarsi; that is the spines on basitarsus are subequal in length 12
12. Metanotum not hairy above; marginal cell much more than its length from the tip of wing . . . . *Pompiloides.*
    Metanotum plainly hairy above, marginal cell more acute at tip. *Anoplius.*

Chalcochares, gen. nov. contains *Psammochares hirsutifemur* Bks.

Sophropompilus includes *P. ingenuus*, *brevicornis*, and *hyacinthinus*.

Nannopompilus includes *N. argenteus*, *rufibasis*, *parvus*, *consimilis*, *padrinus*, and *minusculus*.

Arachnophila includes *P. scudderi* Bks., *divisa* Cr., and *pretiosa* Bks., which is possibly the male of *P. divisa*.

Agenoideus has but one species, *A. humilis* Cr.

Allocyphonyx contains *A. maura* and *harpalyce*.

Sericopompilus based on *P. cinctipes*, which is known only in male, includes also *posticatus* and *plutonis*, males; and *fuscipennis*, *augustatus*, *fulvo-apicalis* and *georgiana*, females.

Gymnochares, gen. nov. is based on *P. birkmanni* known in both sexes, and male *P. biedermani*, both described in Sericopompilus.

Lophopompilus contains *L. aethiops*, *ilione*, *cleora*, and *atrox*, latter marked with red.

Notiochares, gen. nov. is based on *P. philadelphicus*, and its two varieties.

Psammochares contains *P. difficilis*, *relativus*, *hesione*, *bellicosa*, *scelestus*, *astur*, *gracilicornis*, wholly black species, and *autumnalis*, *tropicus*, *atlantica*, *marginalis*, *castella* (?), and *arizonensis* marked with red.

Anoplius includes *A. illinoensis*, *tenebrosus*, *fulgidus* (Fla.), *virginiensis* (type of *Aphiloctenus*), *ithaca*, and *luctuosus*.

Pompiloides includes *P. cylindricus*, *rectus*, *albomarginatus*, *parvulus*, *subcylindricus*, *insolens*, *stenotus*, *solonus*, *minora*, *clystera*, *angularis*, *estellina*, *moestus*, all black species; and *americanus*, *marginatus*, *semirufus*, *reducta*, species marked with red.

PSEUDAGENIA SUBMETALLICA, sp. nov.

Type.— M. C. Z. 10,022. Texas: Austin, 12 March, 1900. C. T. Brues. One specimen.

♀ Black, with not very plain, bluish iridescence, legs and wings black, body black-haired, that on head fairly abundant, that on metanotum sparse, and much shorter than in *P. architecta*. Antennae long, third joint much longer than the fourth; face longer than broad, slightly narrowed above, vertex slightly convex; pronotum plainly, but not strongly angulate behind, metanotum without groove; abdomen hardly polished, hairy toward the tip and on the venter; tibia with small but distinct spines, inner spur of hind tibia not one third the length of the basitarsus; marginal cell acute at tip, third submarginal long, but little longer than the second, recurrent veins meeting cells at middle, basal vein strongly convex basally. Length, 8.5 mm.

AGENIELLA CRASSICORNIS, sp. nov.

Type.— M. C. Z. 10,023. Mass.: Forest Hills, 11 June; Woods Hole. C. T. Brues. Two specimens.

♂ Black, clothed with silvery pubescence; most of mandibles, lower edge of clypeus, and underside of scape yellow, pale on hind border of pronotum, and slightly on sides of second abdominal segments; legs mostly yellow, coxae, mid tarsi, hind tibiae, and tarsi darker, spurs pale. Slender; clypeus very broad, truncate, face broad, wider above, vertex convex, pronotum arcuate behind, metanotum with a broad median groove, basal abdominal segment rather broad; legs slender, inner spur of hind tibia about two thirds as long as basitarsus. Wings nearly hyaline, not darker at tip, second submarginal hardly longer than broad, third not longer and narrowed above, recurrent veins received at middle of cells; basal vein strongly bowed at base, and almost interstitial with the transverse; in the hind wing the cubital fork arises much beyond cell. Length, 5 mm.

AGENIELLA FESTINA, sp. nov.

Type.— M. C. Z. 10,024. Va.: Falls Church, 6 August. Nathan Banks. One specimen.

♂ Black, with silvery pubescence, lower orbits and small spot each side on clypeus yellow; tip of mandibles reddish; basal part of abdomen reddish, tip white, front and mid spurs pale. Body slender, face rather narrow, narrowed above, clypeus truncate, vertex convex; pronotum with hind margin strongly arcuate; metanotum without definite furrow, but rather depressed in middle area, densely white pubescent, basal segment of abdomen slender at base, subpetiolate; hind pair of legs very long, inner spur of hind tibiae about one half the length of basitarsus; wings rather long, darkened throughout, marginal cell acute, second submarginal much longer than broad, third also elongate, narrowed above, recurrent veins received at middle of cells, basal vein slightly bowed at base, only a little before the transverse, in the hind wings the cubital fork arises a little beyond the cell. Length, 8 mm.

AGENIELLA FRATERNELLA, sp. nov.

Type.— M. C. Z. 10,025. Va.: Falls Church, 14 July. Nathan Banks. One specimen.

♂ Black, basal half of abdomen reddish, white spot at tip, spurs whitish, most noticeable on front pairs, wings nearly hyaline, tip not darkened; clothed with fine white pile; clypeus very broad, truncate, face barely narrowed above, vertex convex, pronotum arcuate behind, metanotum without impressed line; abdomen fusiform, very much broader in middle than at ends; legs very long and slender, hind tibia with the inner spur not one half length of the basitarsus. Wings slightly fumose, third submarginal cell much longer than broad, but not much narrowed above, recurrent veins meeting cells at middle; basal vein slightly bowed at base and interstitial with the transverse. Length, 8 mm.

Resembles *A. birkmanni,* but differs in having a very distinct impressed line on the face from antennae up to ocellus, in the more fusiform abdomen, and in the shorter spur to hind tibia.

AGENIELLA MINUSCULA, sp. nov.

Type.— M. C. Z. 10,026. Texas: Dallas, 2 August. One specimen.

♂ Black, with silvery pubescence. Abdomen reddish on side of first segment, legs mostly pale, with whitish spurs; wings subhyaline. Body slender; head short and fairly broad, vertex high, convex, no line from antennae to ocelli; the pronotum rather long, arcuate behind, metanotum without groove; abdomen slender, not much enlarged in middle, polished; femora and tibiae mostly reddish, long spur of hind tibiae more than one half of the basitarsus. Wings short, slender; marginal cell acute, much beyond third submarginal cell; second submarginal short, third very short, outer side convex, recurrent veins meeting cells at middle, basal vein bowed near base, arising a little before the transverse. Length, 4 mm.

Agreeing in general with the northern *A. tenella* but it is much more slender and has a more arcuate margin of pronotum separating it.

SCOLIIDAE.

SYNOPSIS OF ELIS.

The females of the section Dielis can be separated as follows: —

1. Abdomen black, with four large yellowish spots; very large species.................................... *quadrinotata.*
   Abdomen otherwise marked.................................2
2. Abdomen beyond base mostly reddish yellow; thorax and legs white-haired................................... *dives*

Abdomen more plainly banded 3

3. Costal area of fore wings yellowish, legs, head and thorax with much fulvous or golden hair 4

Costal area of fore wings black; body more white- or gray-haired, or all black-haired 5

4. Spurs of hind tibia pointed at tips; band on third segment much narrower than that on the second . . . . *limosa.*

Spurs of hind tibia broad at tips as usual; band on third segment broad and shaped like that on second . . . . *fulvopilosa.*

5. Head and thorax black-haired; abdomen with two broad reddish bands on second and third segments, not emarginate. *ephippium.*

Head and thorax more white- or gray-haired; bands on abdomen more yellowish, and some emarginate in front 6

6. Median posterior surface of metanotum punctured, and with long, erect hair . . . . *pilipes.*

Median posterior surface of metanotum mostly smooth, and with appressed hair, mostly below 7

7. Band on third segment broadly emarginate on sides; body more fulvous-haired . . . . *trifasciata.*

Band on third segment scarcely emarginate on sides; body more gray-haired . . . . *plumipes.*

DIELIS PILIPES Saussure.

Saussure in the Revision of Scolia considers this the female of *Trielis texensis.* To this I dissent, for two males closely agree with the female in coloration and in venation. These males have a rather broad body; rather more densely white-haired than the female; the bands on the abdomen of the same shape as in the female, except that the one on the fourth segment is broader than in the female.

Specimens from Arizona, California, and Washington are at hand.

DIELIS LIMOSA Saussure.

I have specimens of both sexes from Palmerlee, Arizona.

DIELIS PLUMIPES Drury.

I use this name for our common form, although it is possible there are several species or varieties included, and Drury's name may not apply in this sense.

The males of the section of Trielis can be separated as follows: —

1. Legs black; abdomen black, with transverse yellow spots, usually connected .... *hermione.*
   Legs mostly pale 2
2. Abdomen with some fulvous or golden hair especially on sides at tip of the segments; fulvous hair between the antennae. *texensis.*
   Abdomen without fulvous or golden hair; white or gray, and black-haired 3
3. Abdomen very slender, first segment very long; fore wing with apical dark cloud .... *octomaculata.*
   Abdomen less slender, first segment rather broad; no cloud in apical part of fore wing .... *alcione.*

The females of the section Trielis can be separated as follows: —

1. Legs largely yellow; basal joints of antennae rufous 3
   Legs brown or black, antennae all black 2
2. Legs black, no golden pubescence; spots on abdomen transverse. *hermione.*
   Legs brown, pubescence partly rufous or golden; abdomen with large; rounded spots .... *pollenifera.*
3. Abdomen with black hair on margin of segments above, transverse frontal suture sinuate .... *octomaculata.*
   Abdomen with mostly or wholly fulvous hair on margins of segments above; frontal suture not sinuate .... *xantiana.*

TRIELIS ALCIONE, sp. nov.

Type.— M. C. Z. 10,027. Washington: Lone Tree, Yakima River, 18 July, 1882; Big Bend, Yakima River, 19 July, 1882; Ainsworth, 20 July, 1882. Samuel Henshaw. Three specimens.

♂ Black; long, white-haired. Clypeus, pronotum above, scutellum, postscutellum, six bands on abdomen above (basal three more or less interrupted) and apical bands on ventral segments, yellow. Legs yellowish, femora, especially of the front pair, more or less black at base. Margins of abdominal segments above with dark brown hair; no fulvous hair. Sometimes a spot on the pleura and a median one on the metanotum behind, are yellow. The hair is longer, and more dense than allied forms; the abdominal spots are transverse, not rounded behind. There is no dark cloud in the fore wing, and the marginal cell is longer than in *T. xantiana*, and the recurrent veins farther apart at tips than in that species, and the abdomen far less slender. It is nearer to *T. texensis*, but has no fulvous hair. Length, 14 to 20 mm.

TRIELIS OCTOMACULATA Say.

I consider *T. lupina* Cresson the same as Say's species; the markings of the type agree closely with Say's figure.

TRIELIS XANTIANA Saussure.

Though normally this has a rather slender abdomen and the spots are well separated, I consider that the broader form with spots more connate, and with a pair of spots on the third ventral segment also belongs here; this is *T. regina* Cresson.

TRIELIS TEXENSIS Saussure.

This species agrees well with *T. zonaria* Cress., and I think it is the same.

PHILANTHIDAE.

CERCERIS DENTICULARIS, sp. nov.

Type.— M. C. Z. 10,028. Oregon: Umatilla, June, 1882; Washington: Lone Tree, Yakima River, 30 June, 1882. Samuel Henshaw. Nine specimens.

♀ Black, with white marks. Clypeus, except the anterior margin, lateral lobes, bases of the mandibles, supraclypeal spot, sides of face barely reaching above the antennae, spot under the scape, two spots or line on the pronotum, tegulae, postscutellum, sometimes small median spot on basal abdominal segment, others with apical band, broad on sides, narrowed in the middle, subequal in breadth, and the tibiae, yellow. Sometimes apex of front and middle femora pale beneath, tarsi rather dark. Wings mostly hyaline, darker beyond stigma, latter yellowish, veins dark. Venter black. Body densely and rather coarsely punctate; head very broad, clypeus not produced, lower margin emarginate in the middle, above with two minute teeth as in *C. grandis*, but farther apart than in that species; enclosure obliquely striate, less noticeable on the middle: basal abdominal segment very narrow compared with the next. Pygidium long, narrowed to tip, and barely constricted a little before tip. Face with dense white hair, darker above and mostly brownish or gray on the rest of the body, but venter and legs with white hair. Length, 12 to 14 mm.

In some the face-marks are all connected and the supraclypeal mark elongate. The male is smaller (10 mm.), a clypeal and a supraclypeal spot, and one each side on face; there is no spot on the postscutellum (some females have a broken spot on the postscutellum), five bands on the abdomen, the first segment unmarked, and the last band less concave in front than the others; hind tibiae with dark spot near tip, hind femora wholly black. Clypeal hair-lobes narrow, remote; pygidium less narrowed, and not constricted near tip; the enclosure more polished in the middle than in the female.

CERCERIS BELFRAGEI, sp. nov.

Type.— M. C. Z. 10,029. Texas. G. W. Belfrage. Coll. Peabody Academy Science, Salem. Four specimens.

Close to *C. compacta;* the ♀ with the clypeus produced and with the two large lamellae below of the same shape; the ♂ with a pointed clypeal margin. Both sexes are more red than *C. compacta*, and of a size larger; in the female the clypeal process is much broader proportionally than in *C. compacta*, there are large reddish yellow spots on the sides of metathorax, and a median yellow spot behind on the first segment of abdomen; the apical band of the second segment is plainly angularly indented in middle, the pygidial area is proportionally broader, and broader near base than in *C. compacta*, basal ventral segment reddish; punctuation and other marks as in *C. compacta.* The male also has spots on metanotum and on middle of the first segment of abdomen.

The true *C. compacta* also occurs in Texas.

CERCERIS VANDUZEEI, sp. nov.

Type.— M. C. Z. 10,030. Calif.: San Diego, June. E. P. Van Duzee. One specimen.

♀ Similar to *C. finitima*, a small coarsely punctate species; lateral lobes of face black; clypeus, sides of face, supraclypeal mark, bases of mandibles, spot back of eyes, and the scape, yellow; flagellum mostly rufous, but base black; two spots on pronotum, tegulae, tubercles, two spots on scutellum, postscutellum, two spots each side on metanotum, and apical band on abdominal segments, yellow; basal two thirds of femora and apex of hind tibiae black, rest of the legs yellow. Enclosure strongly transversely striate, not punctured as in *C. finitima;* the pygidium is slender and about equally narrowed at each end as in *C. finitima.* The narrowing or indentation of the abdominal bands is present in both specimens, but is uncommon in *C. finitima.* Length, 6.5 mm.

CERCERIS HESPERINA, sp. nov.

Type.— M. C. Z. 10,031. Washington: Yakima, July, 1882; Ainsworth, July, 1882. Samuel Henshaw. Four specimens.

♀ Similar to *C. finitima;* small, coarsely punctured, black species, with clypeus, spot on lateral lobes, sides of face, bases of mandibles, and scape beneath, yellow. Flagellum rufous beneath. Two spots on pronotum, tegulae, tubercles, two spots on scutellum, postscutellum, median spot on first segment, broad band on second segment, and narrow bands on other segments, that on the third sometimes broken into three transverse marks, yellow; most of femora, apical half of hind tibia, and mid and hind tarsi blackish. Face broad, rather densely clothed with short white hair below; enclosure smooth in middle, finely striate on sides; the pygidium broader than in *C. finitima,* but narrowed at each end.

The male is similar; the lateral lobes unmarked; the spot on basal segment may be lacking, the enclosure polished, but slightly punctate on the sides, the pygidium rather broader than in the male *C. finitima,* and barely if at all narrowed at base. Length, 6 to 8 mm.

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THE INTRODUCTION OF WEST INDIAN ANURA INTO BERMUDA.

By P. H. Pope.

With Two Plates.

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CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH, No. 63.

BY P. H. POPE.

BOTH the situation and the physical characteristics of the Bermuda Islands appear to be unfavorable for supporting amphibian life. The situation, over 600 miles from the nearest land, has effectually prevented any natural migration from North America or the West Indies. Consequently there are no amphibians native to the place. The physical character of the country seems to be fully as unfavorable as its location. The porous limestone rock of which the islands are composed allows the water to soak away through it, so that there are no streams or springs, and even stagnant pools of fresh water are rare. Since we think of amphibians as animals that pass through a tadpole stage in water, this shortage of fresh water would seem to be quite enough to prevent the increase of any amphibians that might be introduced.

These conditions would probably prevent the spread of any North American frog or toad, but there are three species which have been brought in from South America and the West Indies, where they are adapted to tropical conditions and consequently fitted to thrive in Bermuda.

The observations on which this paper is based were made during two seasons spent at the Bermuda Biological Station for Research in the summers of 1915 and 1916. I was in Bermuda from about the middle of June to the first of August both years and, incidentally to other work, had the opportunity to study and photograph the species here described.

A grant from the Humboldt Fund of the Museum of Comparative Zoölogy, made this possible. I owe thanks to Dr. E. L. Mark, the Director of the Station, and Dr. W. J. Crozier, the Resident Naturalist, for many courtesies extended to me during my stay and for valuable information and advice. Also to Mr. J. M. Godet of Paget and Mr. N. E. Lusher of 'Grasmere' for specimens and information.

Bufo agua Daudin.

The Great Surinam Toad, *Bufo agua,* was the first of these species to be introduced. F. C. Waite (: 01), writing in Science, gives a brief account of its importation.

"The history of its introduction, as gained from an interview with Captain Vesey in July, 1900, is as follows: Captain Nathaniel Vesey (at present a member of the Colonial Parliament from the parish of Devonshire) 'about fifteen years ago' engaged the master of a vessel plying between Hamilton and Demerara, British Guiana, to secure for him some of the Guianan toads, with a view to using them to catch garden insects. The toads were brought from Demerara to Hamilton, and were carried out to Devonshire by a native, who must have purloined some of the animals, for individuals were seen near the native's home (Tuckerstown), ten miles distant, soon afterward. Captain Vesey liberated 'about two dozen' individuals in his garden, where they thrived from the first and ate many insects."

Dr. Crozier has recently given me further data regarding the spread and increase of the toad,

"F. Goodwin Gosling, Esq., Hon. Secretary of the Bermuda Natural History Society, who has had opportunity to observe Bufo agua in Bermuda since the time of its introduction there, informs me that after several years subsequent to the first appearance of the toads they had increased greatly in numbers, and that individuals of large size were quite common. So numerous were they that in the spring the roads near their spawning places were not infrequently made literally black by hordes of the animals. They became, in fact, something of a public nuisance, through so many of them being killed by carriages upon the roads. But in later years it has been very noticeable that the number of the toads has greatly decreased, and that very large specimens are by no means abundant. Moreover, the largest size now seen does not appear to be anything approaching that of the huge Bufos which were common twenty years ago." — *W. J. C.*

Because of the facts mentioned above, and also because of its habit of getting into water tanks, the big toad was not welcomed at first, and was called Captain Vesey's nuisance. Later it became known that its principal food was cockroaches, and today it is thoroughly appreciated and protected by public sentiment.

In late June and in July I found these toads abundant about road-sides, gardens and edges of mangrove swamps in Pembroke Parish. They are nocturnal in habit, like our American toad (*Bufo americanus*). A street light half way between 'Grasmere' and Hamilton was a favorite place for them, and two or three were usually to be seen under it, picking up the insects that were attracted by the light. If alarmed they travel by a series of rapid hops, giving the effect of a run and going much faster than a person can walk. In the day time they hide under stones or boards, or burrow into soft earth. I have sometimes seen them in little burrows in the side of a bank, where they had dug themselves in just far enough to be out of the sun.

Bufo agua is the largest of living toads. An average female measured 145 mm. from snout to vent, and Waite describes one 155 mm. in length.

The sexes are quite differently marked, as the accompanying photographs show. In general appearance the female resembles our American toad, but there are certain marked differences. The body is flatter and longer in proportion to its bulk and the arms are longer, so that the whole appearance of the toad is less fat and clumsy. The parotoid gland behind the ear is very large, about 38 mm. long and 25 mm. wide, and closely set with pores. These are the openings of glands that secrete a poisonous milky substance, which is exuded when the toad is injured. The bony cranial crests in front of these are very conspicuous, forming a system of dark-colored ridges above the ear and eye, those of the two sides joining in a rather obtuse angle above the snout.

The color of the female is dark brownish gray with a suggestion of olive, while the head parts and dorsal stripe are light yellowish brown. There is a pair of large dark spots on each side of the dorsal stripe. The skin of the back is rough and warty and the warts are usually darker colored than the rest of the back.

The male is smaller, usually about 13 mm. shorter, and more active than the female.

The coloring of the male is pale yellowish brown with only faint traces of the markings seen in the female. The warts are rather smaller and are covered with black tubercles.

The call of the male is a deep, booming trill suggesting that of our American toad but louder and more resonant.

In regard to the poison of this toad, Verrill (: 02) says:

"This toad is believed. . . . to have a very poisonous secretion from its parotid and dorsal glands. It is said that dogs that mouth them invariably die within a few hours. The secretion of the glands, when injected into the circulation of dogs, birds, and other animals, causes convulsions and death, even when in small doses. Mr. A. H. Verrill, of my party, on one occasion saw the venom ejected as a fine spray, from the parotid glands of a large toad, when it was much irritated."

For a good account of the histology of these poison glands, and a fairly full bibliography on the subject, see Shipley and Wislocki (:15).

The eggs are laid in water in the spring. Standing fresh water is scarce in Bermuda, but there are places where pools exist in rainy weather. This water is not always fresh, but brackish water is not refused, and it is said that toads will sometimes lay their eggs in the salt water of mangrove swamps.

The development of an amphibian in salt water seems very unusual, but Glaser (:12) discusses a case of development of frog larvae, described by Pearse (:11), in the mouth of a creek emptying into Manila Bay where the water was partly salt. To account for this Glaser experimented on the larvae of *Rana pipiens* and draws the following conclusions:

"The ability of amphibian eggs to develop in sea water is dependent on the principle of ionic antagonism. In addition to this, however, their power of acclimatization plays an important rôle, for it not only enables them to withstand the passage from dilute to strong solutions, but the opposite process as well. . . . If in addition to this we remember that the species found by Pearse is probably racially acclimated to the conditions under which it lives, his findings do not appear inexplicable."

The breeding season of *Bufo agua* depends largely upon atmospheric conditions. If there is plenty of rain it may begin in February, but if there is continued drouth it may be delayed until July. April is about the usual time.

Clark (:16) and Ruthven (:16) have collected data that show the variability of the breeding season.

Clark quotes a letter from Barbados as saying:

"It certainly lays its eggs at least twice a year. In August last year (1914) ponds in Barbados were full of tadpoles, and again in February this year (1915) the same thing was noticed."

In Trinidad the breeding season is reported as August–October. In Demerara "it appears to breed about the commencement of the wet season, somewhere in November or thereabouts."

Ruthven has made some observations on the habits of the species in Demerara:

"On the Demerara River, about thirty-five miles south of George-town, in 1914, tadpoles were abundant in July and August, and a lot taken during the last week in July reached the adult stage on and after August 16. From this the writer concludes that the eggs were laid about the first of July, and that in Demerara the species breeds in the long wet season, from the middle of April to September first. It is possible that it also breeds in the short wet season, which begins in November and lasts until the end of January, as stated by Bodkin (quoted by Clark), but, in the opinion of the writer, this has not as yet been established."

An interesting question arises here as to whether the toad breeds once or twice a year.

In Bermuda it probably spawns but once, as there are no definite data to the contrary. However, this may be due to the fact that the winter season is much cooler than summer, and probably the toads are less active at that time.

Dr. Crozier has looked for them this winter (1916–1917), but failed to find any, so they are probably in hibernation.

From Ruthven's paper it appears that development from egg to adult requires about forty-five days. Probably this would be shortened by the drying of the pools, as is the case with our northern amphibians. From what I have been told, I think that development must be even more rapid than this in Bermuda. It would be interesting to obtain exact figures on this question, for such a short tadpole stage is unusual.

Dr. Mark has given me the following data:

"In the spring of 1903, in company with Professor C. L. Bristol of New York University, I made a trip to Bermuda. In the course of one of our excursions made at the invitation of the Hon. Ambrose Gosling, the Hon. F. Goodwin Gosling and the late Mr. James Trimingham, we visited 'Spanish Rock' near mid-day April 22. Before reaching the Rock we found, on the slope facing away from the ocean and toward Spittal Pond, a small pool of rain water (there had been a heavy shower the night before), and in this pool there were large numbers of the huge toad — *Bufo agua* — in pairs. The females were engaged in spawning, and the numerous strings of spawn were stretched across the pool in almost every conceivable direction. The pool, some fifteen or twenty feet in diameter and only a few inches deep, was of so temporary a character that its bottom consisted throughout of turf, not unlike that immediately surrounding it which was not submerged. I secured a considerable quantity of the most freshly deposited 'strings' and kept it in a vessel with some of the rain water. Portions of this material I preserved in formalin at intervals, and from time to time made the following notes on the condition of the spawn, which was brought to Cambridge, where I arrived on the 26th of April:

'Eggs laid at about 12 o'clock (noon) April 22, 1903. About 60% to 70% proved to be fertilized.

April 23. Infertile eggs grayish in color. Some of them may have been injured in transportation.

April 24, 4.15 P. M. Egg envelopes becoming attentuated, not so stiffly gelatinous. Strings tending to float (due to decomposition of infertile eggs?).

April 25, 8.00 A. M. All embryos have pierced their envelope and are clinging to it by the head, on the outside (of the envelope). Infertile eggs still remain in their envelopes.

9.30 A. M. First perceptible movements, slight quivering; embryos still adhering by head to remains of envelope.

April 26, 8.30 A. M. Much more active; those where envelope entirely consumed moving about with motion of larvae of mosquito. Some clinging to leaves.

9.30 A. M. All freely swimming.

April 27, 8.00 A. M. All swimming or clinging to sides of aquarium.'

E. L. MARK."

In addition to this, Plate **2**, fig. 7, 6 show eggs and young tadpoles which were collected by L. J. Cole in July of the same year (1903). The eggs closely resemble those of *B. americanus* both in size and appearance. Shrinkage of the eggs in the formalin in which they are preserved makes it almost impossible to identify the exact stages of development, but it is plain that none of the eggs were past the early cleavage stages. The tadpoles are black in color and resemble those of *B. americanus*. They measure from 8.5 to 10.9 mm. in length. They have the typical early tadpole form. The buds of the hind limbs are present, but hardly visible to the naked eye.

This material was dated July 27 and July 31, 1903. The following note shows where it came from:

"B. B. S. Station 1406, July 26, 1903.

A small fresh-water pond to the west of the Middle Road just south of 'Green Hill.' Pond only 20–30 feet from the roadside (Lat. 17′ 58″ Long. 44′ 52″). Pond is about 20 feet long and 8 feet wide. At present contains about 1½ Ft. water from heavy rain early in the morning (3 A. M.) of July 25th. The water of the Pond is green with some microscopic alga. Bufo marinus breeding in large numbers.

L. J. COLE."

The place spoken of is located near the southeast margin of Devonshire Marsh. It is perhaps three miles from "Spanish Rock," where the other eggs were found April 22nd of the same year. I am somewhat at a loss to explain why one group of animals should spawn in April and another group only a few miles away should wait till July. I do not think that the same toads were spawning twice in the same year, for the dates are only three months apart.

Metcalf (: 14) has described a new species of Opalina found in the rectum of some specimens of *Bufo agua* collected in Jamaica. Since the Bermuda toad came from Demerara, it would be interesting to see whether it, too, is infested by the same parasites.

ELEUTHERODACTYLUS JOHNSTONEI BARBOUR.[1]

The "whistling frog," *Eleutherodactylus johnstonei*, was introduced accidentally. I have been told that it was brought in at Admiralty House, Spanish Point, about 1886, probably coming from Jamaica, since palms and ferns are often brought from there to Bermuda, and that it spread slowly at first, but much more rapidly during the last ten years.

In a recent letter Dr. Crozier says:

"The 'whistling frogs' were here before 1880 in very small numbers. In that year Lady Bedford, wife of Admiral Bedford, brought to Admiralty House from Jamaica a pair which were liberated. (So says Mrs. Abbott, editor of the Gazette)."

These data appear to be correct for the most part. It is highly improbable, however, that the animal came from Jamaica, for it has been reported only from Barbados, where it is supposed to be native, and from Grenada, where the type specimens were taken. Since both these islands are, like Bermuda, British possessions, it is not unlikely that it came from one or the other of them instead of Jamaica.

Its range in Bermuda now extends from the Causeway, on the north, to Paget on the south. The animal is surely abundant enough south of Castle Harbor, and this summer I heard a single one in the town of St. Georges, showing that they have crossed the Causeway. Southward they have reached Paget but have not spread beyond there.

The creature itself is a tree frog with well developed adhesive discs on its fingers and toes. It is not a Hyla, like our North American tree frogs, but belongs to a nearly related family, the Polypedatidae. The differences between the two families are in the structure of the skeleton and will not be discussed here.

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[1] For description and figures of this species see Barbour, 1914.

The "whistling frog" (Plate 1, fig. 2; Plate 2, fig. 5), as Bermuda people call it, is very small. A large female measured 28 mm. long, while the average male is about 22 mm. in length.

In color they are grayish brown above with darker transverse bands in front of the eyes, between the shoulders, and above the sacral humps. The distinctness of these markings depends upon the phase of the animal's coloration. In the day time the color is usually very dark and the markings hardly show, but at night it becomes pale and then they are quite conspicuous. The hind legs are barred with dark. The under parts are pale and not spotted. The skin is comparatively smooth except underneath, where it is granular.

A striking peculiarity of this group, which especially fits it for life in Bermuda, is the fact that in development the entire larval stage is passed in the egg, a free-swimming tadpole stage being unknown. The eggs are laid either on plants or under stones on damp ground and the young hatch out in the form of perfect frogs, quite able to take care of themselves.

Until lately nothing was known about the breeding habits of this species. In July I found females full of large eggs and concluded that the breeding season was in the fall. This has been confirmed by a recent letter from Dr. Crozier in which he says:

"Sept. 15, 1916. In Paget I found some eggs which I took to be those of E. johnstonei. They were fastened to twigs, ... about a dozen in a cluster, all 'round the stem. Eggs 1–1.5 mm. in diameter."

In June and July I found "whistling frogs" very abundant all through Pembroke. They occur almost everywhere, especially, however, in thickets of oleander and cedar, and most abundantly in swampy places and in growths of Bryophyllum or "life plant." The old quarry at Pembroke Crossroads, shown in Plate 2, fig. 8, was my favorite hunting ground. I took about 50 from the place last year and fully as many this year, but the number did not seem to be diminished thereby.

I found it easy to catch them at night by following up their call with a light. They usually sit on a sloping leaf or rock, always with the head downward and the hind legs half spread. The male has a large, collapsible throat pouch, wanting in the female, which opens from the floor of the mouth by a pair of slits, one on each side of the tongue. When the call is given this pouch is expanded like a great bubble until it is larger than the head. Then the air is taken back into the lungs again, expanding the body in turn, while the throat pouch nearly disappears. The flash-light picture (Plate 2, fig. 5) shows a male sitting on a rusty tin box and singing. The call had just been given, the throat pouch was collapsed and the body inflated when the flash went off.

The call is a thin, high-pitched whistle, somewhat like that of the Spring peeper, *Hyla pickeringii,* though rather more bird-like than that. Some notes are trilled a little, but the general effect is much like the spring chorus that we hear in the swamps. Unlike that, however, this chorus is not a temporary thing during the breeding season, for it continues all summer, apparently as long as the animal is active. Residents say that the chorus begins in April and ceases late in October or early in November, when the animal becomes dormant.

This story of the hibernation of the frog may or may not be true. The call ceases, but whether the frog is still active I do not know. It may really be hibernating or merely silent during the winter. Since most of the people have never seen one, they have no way of knowing except by the call.

Dr. Crozier tells me that his observations in 1915 agree with the popular idea, but in the winter of 1916–1917 they continued calling in small numbers most of the winter. His latest word on the subject follows:

"Mar. 16, 1917. I have not heard a 'whistling frog' now for about three weeks, perhaps a little more."

"April 15, 1917. Search for nests of E. johnstonei resulted in discovering several quite 'sleepy' nests of them on April 10th, and on April 14th I found under my front door step, buried in moist earth, a closely packed batch of more than a dozen. They 'came to life' very quickly, and in two minutes were jumping all over the place. A number were secured. The woods are full of them, singing as I write — as least it sounds so."

It is their abundance and their persistent singing that makes Bermuda people consider the "whistling frogs" such a nuisance. The call is not disagreeable in itself, but I can readily see how anyone could get very tired of hearing it all summer long from the shrubbery under his window. When I was collecting them beside the road the usual comment of the passerby was: "I wish you'd catch them all."

In spite of its long continuation, the call may be the mating song of the male, for I have seen behavior that may have been equivalent to a courtship. On July 6, 1916, I saw three pairs acting in the following way. The male was singing loudly and the female was sitting near by, watching him from a distance of one to six inches.

The "whistling frog" is nocturnal in habit. I have heard its call as early as half past five in the evening and as late as seven o'clock on a wet morning, but never a sound through the heat of the day, the day time being spent in hiding, usually under stones or in stone walls or rubbish.

The exception to this rule is seen in the following note by Dr. Crozier:

"On October 31st, 1916, I noticed that the 'whistling frogs' were singing loudly at 1 P. M. It had begun to rain rather heavily, and the sky was much overcast. During the next succeeding three days, the rain continuing all the while, the tree frogs kept up a steady chorus throughout the whole of each afternoon. They did not sing in the morning (9–12 A. M.), but it is quite clear that under proper conditions of moisture and absence of strong light, the singing of these frogs is not restricted to the night hours. It may be significant that this time of year appears to be that of egg deposition."

Females are rarely seen at night. It is the males alone that sing and thus make themselves conspicuous. I have caught several by turning over stones in the quarry, where they were abundant at night. But even in the day time the males seemed about twice as common as the females.

The food is interesting as showing what economic value is to be attached to this ubiquitous noise-maker. An examination of fifty-eight stomachs showed that the "whistling frog" is not at all particular what it eats. Almost anything alive that is not too large to swallow appears to be satisfactory. A partial list of the material found in the fifty-eight stomachs follows:

Aphids	60	specimens
Insect larvae	36	"
Ants	29	"
Various Diptera	24	"
Spiders	22	"
"Pill bugs" (Isopods)	14	"
Centipedes	9	"
Young of *E. johnstonei*	1	"

On the whole the list is decidedly favorable for the case of the frog, and we must conclude that it is not the unmitigated nuisance that Bermuda people consider it.

ELEUTHERODACTYLUS LUTEOLUS GOSSE.

In June, 1916, Mr. J. M. Godet sent to the Station several specimens of an Eleutherodactylus new to Bermuda. These frogs had been caught and brought in alive by Mr. Godet's cat. The cat certainly qualified as a good collector, for in the course of the summer he brought in about twenty-five specimens. Later in the season Mr. Godet was having a stone wall near his residence removed and his workmen came across many of these little frogs hiding under stones.

The new frog (Plate 1, fig. 1), which Dr. Thomas Barbour has kindly identified for me as *Eleutherodactylus luteolus*, hitherto found only in Jamaica, appears to be a little larger than *E. johnstonei*, yet the average female measures only 28 mm. The difference is in girth of body rather than in length, for it is not quite so slender. Besides this, the males are larger in proportion and do not seem to outnumber the females as much as in *E. johnstonei.* In color the creature is pale gray, changeable to dark gray. The under parts are paler and the skin there is granular. Indistinct barring shows on arms and legs. There is a dark streak, edged anteriorly with white, between the eyes and rather faint dark markings on the back. These are situated between the armpits and at the sacral hump, corresponding to the more distinct markings seen in *E. johnstonei.* A black line extends from snout to eye, and the ventral two thirds of the iris is dark. Behind the eye the line continues along the side and is edged ventrally with black blotches to a point just back of the armpit. In about half the specimens that I handled there was a distinct, light vertebral line running back from the snout to the vent, where it bifurcates and extends along the posterior side of the thighs.

Nothing definite is known about the introduction of this species. Mr. Godet tells me that its peculiar call has been heard in Paget for at least ten years. It seems to be most abundant near his home in Paget about opposite Isle of White, but it does not occur west of Paget. I have heard a few, and collected one, at Pembroke Crossroads but have not heard them further east.

The call is very hard to describe. It is a soft, chuckling note, almost a trill. It is not very loud and seems to require little effort. The throat pouch is slightly expanded, but the body does not become inflated as in *E. johnstonei.*

In going from Hamilton to Paget one evening I heard both *E. luteolus* and *E. johnstonei* near the city, but as I went further out the latter became less abundant and the former more so, until, in the region opposite the Isle of White, the shrill pipe of *E. johnstonei* was not to be heard, while the softer note of *E. luteolus* filled the air, suggesting a chorus of toads in the distance.

Whether this region marks the present western limit of the range of *E. johnstonei*, and, in case it does, whether *E. luteolus* tends to crowd it out in the struggle for existence, are interesting questions still to be settled.

Another question in regard to distribution comes up in this connection. In the case of the toad, we have seen that it became very abundant soon after it was introduced but that now its numbers have decreased until it is little more common than the American toad in New England. Both species of Eleutherodactylus are spreading in Bermuda and both are extremely abundant within their present range. It remains to be seen whether they will decrease in numbers, as the toad has done, when they have spread over the whole extent of the islands.

The females of *E. luteolus* contained large eggs in July. Barbour (: 10) says:

"The development of this frog is of interest. The eggs, from thirty to thirty-five in number, are laid in depressions in damp ground under stones or logs. Mr. Wight has also found these nests and writes:

'Port Antonio, Jamaica, Nov. 30. Thirty-three eggs in slight depression, damp ground. Eggs scarcely adherent. Movements of embryos visible. 168 hours later two frogs hatched. After 312 hours the whole lot had taken on the light brown color which is typical of many adults.'"

Dr. Crozier, in the letter of Sept. 15, previously mentioned, confirms this observation:

"Also eggs, which I take to be those of the other, larger form (which on dissection now seems 'ripe'), were found among stones in an old stone wall. *These* eggs were laid in a cluster of about 30, closely adhering to one another upon damp, firm earth; the eggs in this case were 3 mm. in diameter, the jelly being somewhat swollen."

In another letter dated Feb. 1, 1917, he says of its winter habits:

"The E. luteolus does not hibernate, at least not invariably. Mr. Godet's invaluable cat is still catching them in small numbers."

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PLATE 1.

PLATE 1.

Fig. 1. *Eleutherodactylus luteolus* Gosse. × 1.
Fig. 2. *Eleutherodactylus johnstonei* Barbour. Female. × 1.
Fig. 3. *Bufo agua* Daudin. Female. × ½.
Fig. 4. *Bufo agua* Daudin. Male. × ½.

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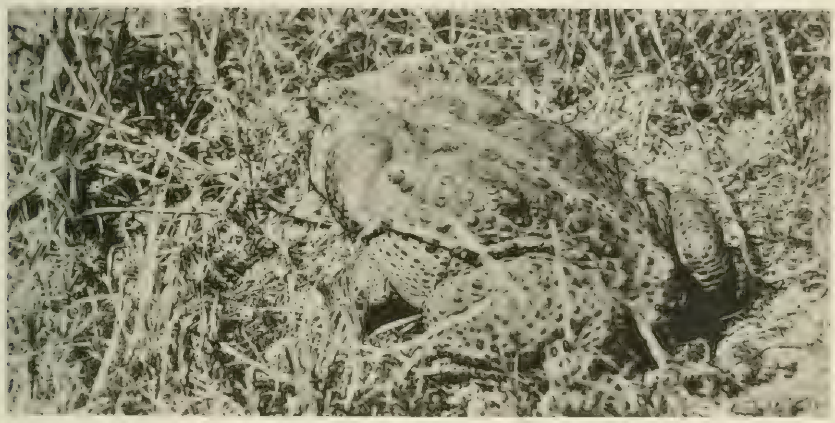

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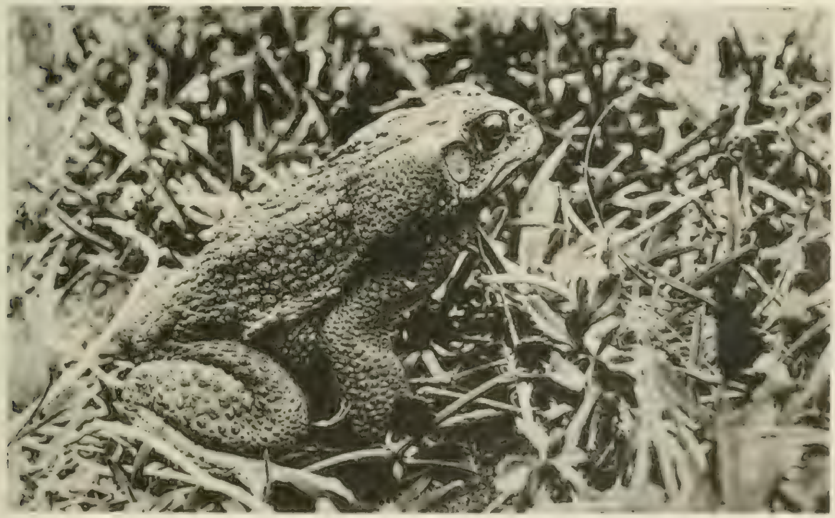

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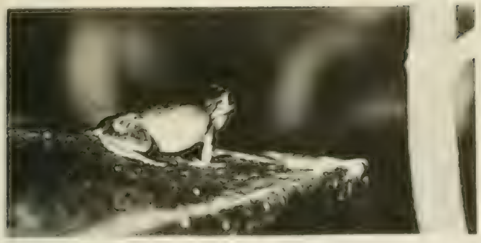
PLATE 2.

PLATE 2.

Fig. 5. Eleutherodactylus johnstonei Barbour. Male singing. × 1.
Fig. 6. Bufo agua Daudin. Young tadpoles. × 1.
Fig. 7. Bufo agua Daudin. Eggs. × 1.
Fig. 8. Abandoned quarry at Pembroke Crossroads, showing in the foreground growth of Bryophyllum.



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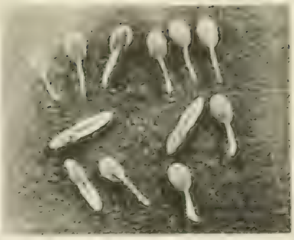

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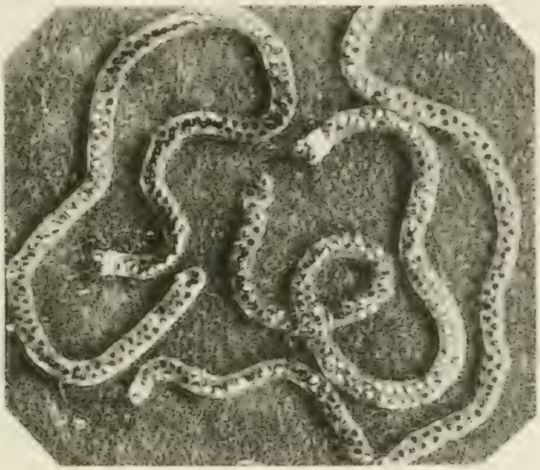

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXI. No. 7.

NOTES ON SOME FALKLAND ISLAND BIRDS.

By W. Sprague Brooks.

With Three Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
June, 1917.

No. 7.— *Notes on some Falkland Isand Birds.*

By W. Sprague Brooks.

The following notes are based upon a collection of birds made during the J. C. Phillips expedition to the Falkland Islands.

A description of the islands and their almost intolerable climate seems unnecessary as these have been well cared for by other writers.

As travelling facilities render it impossible to accomplish one's aims in a single season, the list of species is by no means full, and the breeding notes very meagre.

Besides some weeks at Port Stanley, a month was spent at San Carlos, East Falkland, and two months at Port Stephens, West Falkland.

The vernacular names in quotation are those used by the colonists.

It seems a matter of no great time when a number of the species antagonistic to sheep culture will become very rare, perhaps exterminated.

I am very grateful to Dr. John C. Phillips for permission to study the collection and to Mr. Outram Bangs of the Museum of Comparative Zoölogy for kindly assistance.

Podiceps rollandi Quoy & Gaimard.

"Golden Grebe."

This beautiful grebe is fairly common I was lead to believe, but during the summer its distribution is quite local as it breeds in ponds of varying size not far from the sea. In winter, it, like other grebes, is to be found on salt water generally near the shore.

With the exception of a pair noted on December 2, 1915, at Egg Harbour, East Falkland, the only others seen were nine adults and two downy young on a pond some thirty acres in extent lying close to the sea at San Carlos, East Falkland. Like most birds of the Falklands they were singularly tame, the pair with the young swimming across the pond to within a few feet of me showing the greatest curiosity as I, unaware that the species existed there, sat at the margin of the pond.

I was too late to find any nests, but was told by a resident that these birds nest on the shore very near the water. There was no growth of aquatic vegetation to be seen that would afford the opportunity to nest in the manner adopted by most of the group.

The eyes of adults are red, the tarsi blackish gray, the lobes gray.

The following description is of a downy young, M. C. Z. 70,574, taken at San Carlos November 7, 1915.

General color above sooty brown, some of the feathers light buff terminally. Sides indistinctly barred with gray and rufous buff; breast and upper abdomen white; lower abdomen and crissum gray.

The head-pattern similar to *P. americanus.* Stripes on crown light rufous and black; lores gray with tinge of buff; subocular stripe pure white immediately beneath the eye, light rufous posterior to this fading to dirty white. Small malar spot of black on each side of head. Neck striped as in *P. americanus* with sooty brown and dirty white with slight buff cast. Chin and upper throat white; upper breast feathers light rufous with gray terminations. Eyes dull gray-brown; legs and toes slate color.

APTENODYTES PATAGONICA Miller.

King Penguin.

This is a rare bird in the Falkland Islands, stragglers being occasionally seen during the winter.

It was my good fortune to find a single male on January 4, 1916, at Port Stephens, on a small sandy beach in the midst of about two hundred Jackass Penguins. This specimen was in good condition and though not very fat weighed thirty-five pounds.

PYGOSCELIS PAPUA (Forster).

Gentoo Penguin.

This is an exceedingly abundant species, gathering in colonies of from two or three hundred pairs to countless thousands.

C. C. Abbott writing in the IBIS, 1860, p. 336, states that at that time both Jackass and Gentoo Penguins "hauled up" in September and began to lay each season almost to a day on October 7. Nowadays the colonists tell me that both these species generally lay on October 17, as was the case on my visit in 1915. An old resident told me that formerly within his memory they nested earlier.

In the Falklands the Gentoos seek a variety of sites for their colonies, but never do they ascend to the tops of any of the hill ranges, the summits chosen, if any, being of comparatively low grassy hills, but often the greater part of a mile from the beach. Mr. Murphy's hypothesis (Bull. Brooklyn inst. arts & sci., 2, p. 115-116) that penguins still seek the heights on account of early glaciation, when the ridges separating the ice-filled valleys were undoubtedly the only bare spots, seems very reasonable.

Today in the Falklands, where man has been since the middle of the eighteenth century, many penguins still run inland when frightened, retaining the primordial fear of the seal; reaction to the stimulus of fear still sending them away from their most natural element, where their worst enemy has always existed.

The colony at San Carlos was on a grassy hilltop about three quarters of a mile from the beach. The approach was up a steep, winding, sandy ravine, an ascent requiring many rests for the birds before arriving at their destination, and a difficult walk for a man.

The Port Stephens colony, where most of my observations were made, was quite different. Here the main colony was in a low valley between the sea and the bay of Port Stephens. On the steep sides of the valley were several small units of the main colony comprising sixteen in all. The beach on the ocean side was only used.

Nest-building, such as it is, is for some of the birds a long, arduous task showing little progress, for while a bird is away finding a pebble or a bit of peat, its neighbors help themselves to whatever has thus far been brought to the nest. The owner does not show any concern, but continues patiently, and when opportunity affords selects material from an absent, but thus far more fortunate neighbor. If caught in the act of pilfering a lively chase ensues. These birds are very particular in choosing just the right bit of peat, often turning it about for some time before finally rejecting or appropriating it. Anything of a bright color is treasured by all, and a piece of tin or empty shotgun shell placed on one side of a colony is taken from nest to nest, until in a few days a long series of thefts may bring it to the other side. The pleasures of nest-building continue long after the eggs are hatched, some birds, even in December and as late as January 21, were to be seen industriously waddling along with material that was carefully placed in a pile near some nesting group. More rarely a pebble or lump of peat will be carried from far back in the colony to the water's edge, where the owner leaves it and enters the sea, having apparently satisfied itself by taking the greatest amount of trouble in its trip to the ocean.

The full complement of eggs in these islands is two; sometimes three are found in a nest, but the third has been stolen from a neighbor. Both birds share in incubation for the eggs cannot be left exposed owing to the cold, and especially to the depredations of skuas, Scoresby's and Dominican Gulls. I was told even the beautiful little "Fork-tailed Gull" (*Larus glaucodes* Meyen.) will at times peck holes in the eggs.

When a gull or skua comes close to the nest the sitting bird generally gives a peculiar groaning sound of warning. When uttering this sound the sitting penguin points the bill straight in the air, extending the head as high as possible and stretching the whole body to its utmost. The bill remains closed and the head often rotates from side to side; the eye is bright and watching carefully all that happens. Under most conditions penguins' eyes are half closed on land, giving a drowsy appearance.

A short, vibrant "ah" is uttered often on landing at the beach, joining the young, or when settling on the nest after being disturbed.

The characteristic trumpeting that one hears at all times at the colony may be heard a long distance. It is usually given in series of three, but is often continued for a considerable time. The bird as a rule extends its head in the air with the bill pointing upward and open. On exhaling the sustained characteristic bray is given, then a brief inhalation with a short more highly pitched note, an exhaled bray and so on. This trumpeting is heard always, and though it often seems to indicate defiance, it more often appears to replace the songs of more gifted birds. I would often have a group of fifty or more penguins about me as I sat by a mound of peat at the colony, and every few moments a bird contentedly dozing would awake, slowly extend its head and trumpet, apparently for the sole purpose of expressing its animal comfort, then resume its sleep, preen its feathers, or perhaps stroll slowly about.

The very young Gentoos have a thin, chirping note. As they become larger and able to move about a little, on becoming hungry, frightened, or disturbed in any way, they resort to feeble, quavering trumpeting, quite a pathetic sound as they teeter about with the precarious balance of a child. The young about three quarters grown sometimes point the bill in the air, and imitate very well the groaning sound of warning given by the adults.

No opportunity was afforded to determine the exact incubation period. On November 22, 1915, the first downy young were noted at San Carlos. At the Port Stephens colony, which had been robbed of three or four thousand eggs, about half the nests contained downy young on December 6.

The young, although absolutely helpless upon hatching, develop rapidly, obtaining a great deal of nourishment if the prodigious distention of their abdomens is any criterion. They are fed from the contents of the parent's crop; the parent after retching a moment brings the contents of the crop into the upper throat, and throwing the head forward and opening the bill within reach, the young bird thrusts its bill into the open mouth and picks the food out of its parent's throat.

During the first stages of development the parent protects its young as much as possible from skuas and the weather, but this amounts to little as regards weather for the best the old bird can do is lean forward and turn its back to the wind allowing the young to huddle in the lee with their heads between its legs. The young seek this, their only shelter, until quite large.

As soon as the young are able to toddle about their lives are fraught with difficulties. Early in January they are to be seen wandering irresolutely around not far from the old nest, crying feebly and attempting to pursue any adult in quest of food. If their wandering brings them within reach of neighboring youngsters a fight ensues with much pulling and biting, ending usually in the loss of the very precarious balance of one or both of the combatants.

Most of the adults will no more tolerate the intrusion of a young bird than an adult upon what they believe is their own little plot of ground. Some helpless youngster just able to stagger about, when within reach of a "testy" old bird will receive a merciless pecking delivered with as much vigor as on a grown bird.

About the middle of January the young are able to take care of themselves sufficiently to band together in "nurseries" under the care of a few adults, and here they lead a life of more or less independence except in the matter of food. Early in February the young in some of the outlying units of the Port Stephens colony had matured enough to enable both the young and their parents to forsake the "suburbs" and join the great throng in the valley below.

In the young the appearance of the adult plumage is first noted on the head and tail, then the back, then underparts, and lastly on the lower neck and shoulders. The remaining down on the neck and shoulders gives the birds the appearance of wearing fur-capes. The wings begin moulting early.

The first young in full adult plumage were observed on February 3, 1916, and were easily recognized at a distance on account of their grayish blue backs. Their voices at this time are still distinguishable, and their waddle more pronounced than that of old birds. Yet they are able to give a reluctant parent a long, hard chase in the hope of getting food. They take to the water in March.

The first sign of the postnuptial moult of the adults was on January 17. During the latter part of December their backs were very rusty. When preening immense numbers of feathers were picked off, and in a few days these discarded feathers were carried by the wind into all the gulleys and depressions, until they seemed as if filled with snow. During this moult the birds are very disreputable in appearance, and stand about avoiding the water. By February 3 some had acquired an entirely new dress except the tail. My observations agree with Mr. Murphy's in that the rectrices are lost after the contour feathers.

The curiosity of Gentoo Penguins has been noted by all observers. One generally finds them trudging along as if on an errand of the utmost importance, but they cannot resist stopping to examine any object savouring of novelty. If one remains quietly seated by a colony, it is but a short time before a group of these birds form a semicircle about one at a distance of only a few feet. A quick movement may stampede the flock, but they soon return and doze or idle about in the immediate vicinity. They do a great deal of sneezing, very modest little sneezes to be sure, but they all seem to indulge frequently.

In stretching themselves the head is thrown forward, and the wings extended over the back often meet at the tips.

The wings can be flexed to a certain degree but not nearly as much as Rock-hoppers or Jackass Penguins. A Gentoo sometimes rubs its head on the angle of a slightly flexed wing, but more often the same result is attained by throwing the foot over, not under the wing, a feat requiring, I should imagine, a steady balance.

Contrary to Mr. Murphy's experience I found the Gentoos very pugnacious among themselves. Sometimes they peck and bite exclusively, sometimes they depend on their wings, and often use both. When one has suffered enough it runs away and is perhaps followed by the victor for a few final blows. The young, as stated before, fight as soon as they are able.

Although adults very often rest by lying flat on the ground with wings close to the sides and feet drawn forward under the feathers, the young sprawl with wings outstretched and feet extended behind. In this attitude the bird sleeps soundly, and one can be approached without waking so as to touch it with one's boot. A bird suddenly aroused in this manner requires a surprising length of time to realize what is the matter and adopt some measure for protection, due no doubt to their eyes being better adapted to subaquatic vision.

One of the most astonishing characteristics of these birds is their ability to go to and from the sea in the heaviest surf, which in the Falklands far exceeds what prevails in the north Atlantic. On entering the water they are in a great hurry to become submerged where naturally their progress is far more rapid. On reaching the wash of the waves they often lie flat on their bellies in water that does not nearly cover, and beat their wings rapidly but with no results; until they arise and walk to deeper water, or an incoming wave overtakes them in their futile endeavors, and covers them sufficiently for the use of their wings as they are swept to deeper water. Generally they come to the surface before each comber, and diving immediately swim under it. Diving requires no effort or "curling over" as is necessary with other water-fowl. A penguin floats so low that the wings are always under water so that it can use them on the surface; to submerge the bird merely puts its head under water and disappears. I have never seen them use the feet in swimming, they are trailed behind as with a flying bird.

Coming in from the ocean is rather more of a struggle owing to the undertow, but it is always successful. A group will be coming towards the shore with characteristic porpoise-like plunges. When near the shore they dive, and, approaching at a tremendous rate when in about ten inches of water they pop up to a standing position, and the indefinable shadows hurtling in are transformed with the quickness of a flash into dripping penguins running up through the spume onto the dry beach.

Their rapidity under water is well known and I estimated their wing-strokes to be about two hundred to the minute. The dark body of one of these birds travelling at full speed below the surface appears more like the shadow of a small cloud borne rapidly along on the strong Cape Horn westerly. The "porpoising" is very graceful, the birds entering the water in clean cut dives like salmon. In fact a fellow-passenger on the steamer from Port Stanley to Valparaiso thought a flock of penguins "porpoising" alongside were fish of some sort. During these brief periods in the air these birds manage to inhale sufficient air for their hunting below the surface.

A few Gentoos now winter along the beaches in the Falklands, though an old resident told me that this has been a recent change in their habits. Abbott (Ibis, 1860, p. 336) states that the Jackass Penguin at that time was the only penguin to be seen on these shores in winter. At present none of this species are noted at this season.

Gentoos have been, and are of considerable economic importance on these islands. The eggs have always been a welcome relief from the rather monotonous diet of mutton. They are sold at a reasonable figure, and collectors are required to pay a certain tax per thousand eggs. The skins were formerly sold to some extent until recent legislation put a stop to this traffic as well as the penguin-oil industry. The latter was a particularly cruel and abominable means of obtaining a livelihood. When the birds were fattest (in the spring when they "hauled up," and during the autumn moult) the crews of schooners would visit colonies and set up try-pots for rendering the oil, and corrals into which the birds were driven by thousands and clubbed, the corral containing several layers of birds, the lowest often being crushed and smothered. A penguin furnished about a pint of oil, a gallon of which brought 2/6. A sea captain engaged for years in this business told me that his vessel annually destroyed about 70,000 birds.

Pygoscelis antarctica (Forster).

Antarctic Penguin.

Only one example of this beautiful penguin was seen, an adult female walking on the "camp" about fifty yards above a small creek. It was thin and I imagine was going inland to die, although as soon as captured it showed an abundance of vigor.

My observations made in a few moments were meagre indeed, but suggested that its ways might not be greatly unlike its generic cousin *P. papua.* Upon liberating the bird it did not run, but at first gave a cry very similar to a Gentoo in great terror. Then it stood quietly while I took photographs, though if I moved quickly it extended its head straight in the air, and rotating it slowly from side to side uttered that strange groaning sound that Gentoos on the nest give when approached by man, skua, or gull.

My journal records the color of this bird's eyes as a rich brown and Mr. Murphy records (Bull. Brooklyn inst. arts. & sci., **32**, p. 130) the colors in specimens taken by him at South Georgia as straw-color. The tarsi were white, the nails black.

EUDYPTES NIGRIVESTIS Gould.

Rock-hopper Penguin; "Rocky".

This is an abundant bird on these islands.

My first introduction to this interesting species was at the Gentoo colony at Port Stephens, where previously I had often seen Jackass Penguins making short furtive tours of inspection. On this day I noticed in a casual way what I took to be a small immature bird of this species until attracted by its extraordinary means of locomotion; a series of jumps for all the world like a man running a sack-race, but bouncing along with such rapidity that I had no little difficulty in securing it before it reached the water's edge.

Several others were occasionally seen at the same place. When not alarmed or in a great hurry they were walking, leaning forward and lifting the feet high in an uncertain manner as do Jackass Penguins; neither having the balance and confident gait of the Gentoo. Rock-hoppers usually have the head thrust forward giving them a guilty, hang-dog expression, the crests and sleek black backs rendering them very uncanny and implike. At times they progress with a rolling hoppity-hop gait. When one of these birds is hopping about, especially with that degree of energy stimulated by great fear, it thrusts its head forward and downward on landing squarely on both feet simultaneously, and, immediately throwing its head up, the body straightens and it seems to bounce off the ground for another leap, continuing with a rapidity of progress that is astounding.

No opportunity to visit a colony could be had until it was too late in the summer to obtain any data as to breeding habits. The most surprising feature was how any bird lacking volant powers could reach the very top of the jagged cliff occupied by the colony. They seem to enjoy struggling to the most inaccessible places. Their toes, unlike those of Jackass or Gentoo Penguins, are very flexible and prehensile; these failing they often have bad falls, though by bearing down with the bill and wings they save themselves and slowly crawl to a better footing. A hard drop of several feet does not lessen the bird's courage, on the contrary it appears to augment its determination. They can leap across surprisingly wide crevices, although I found one bird at the bottom of a deep crevice from which I was unable to rescue it, and where it undoubtedly starved.

The landing-place looked very difficult, the penguins being forced to plunge into a mass of heavy kelp twisting about in the surging sea, and returning were thrown up in such a violent way that one would think every bird would be injured. Beyond the breakers bands of "Rockies" would paddle lazily about not in the least disturbed by schools of large porpoises that often swam about them.

About the colony these birds are very tame and upon the visitors becoming seated, will walk up in small groups with much bowing and swinging of wings until within three or four feet. After watching one a few minutes they sit idly about, hop around, on their own particular business, or engage in the popular penguin recreation of fighting. They do not fight with the wings as much as Gentoos, but prefer a kind of "set to" suggesting young domestic roosters. Two birds will face each other, and with heads extended, bills open and almost touching they will peck at each others bill, each turning its head and attacking from every angle at its command.

The young are far more pugnacious than young Gentoos and never miss an opportunity to peck and tear each other.

The only sound I have heard Rock-hoppers utter is a hoarse, grating sound.

According to Kidder the tarsi and toes are white. In the living bird one finds a delicate pink suffusion, becoming white immediately after death. The nails are black.

SPHENISCUS MAGELLANICUS (Forster).

"Jackass Penguin".

This is an abundant species on the Falklands, though my only opportunity to visit a colony was at Kidney Cove near Port Stanley. This was October 17, the day that they, like the Gentoos had commenced laying.

The colony contained many burrows in the soft peat-banks, and those without eggs generally had both birds inside twisting their heads about to better observe the intruder. A considerable number were standing at the entrances suggesting prairie dogs; their sight is quite keen for they would retire within the burrow while we were some distance away.

The burrows are three or four feet deep, about right for using a walking-stick for removing the eggs. This species is the worst biter; it does not peck but tears ribbons of flesh from the hands, which with their power to lunge forward makes the gathering of eggs a task requiring proper implements.

The eggs are sometimes gathered for food but they are strong and undesirable. A professional gatherer of eggs assured me that on his first visit to a colony he always found a few runt-eggs, but that after destroying these all subsequent laying was normal. It seems odd that a bird should produce runt-eggs on its first laying.

On the night of December 2, the little steamer spent the night in Fox Bay, on West Falkland. It was beautiful clear weather, and all night one could hear the doleful braying of these birds from a large colony on a tussock island in the centre of the bay.

Quite a number of Jackass Penguins were wont to frequent the beach at the Gentoo colony at Port Stephens; about a hundred on December 5, increasing to some four hundred by the middle of January, half of which by this time were immature birds. They no doubt came from Bird Island lying about five miles offshore.

On the beach they were very wild, but in the water they became entirely changed, great bands of them swimming close to the beach and following me as I walked along the water's edge. There they would swim right where the waves were breaking being churned about, but never being injured, and seeming to enjoy it.

The heaviest specimen taken was an immature bird weighing $12\frac{3}{8}$ pounds; the adults weighed between $9\frac{3}{4}$ and $10\frac{3}{4}$ pounds.

MACRONECTES GIGANTEUS SOLANDERI Mathews.

Giant Petrel.

I was unable to travel far enough west to find this species breeding.

On December 7 at Port Stephens a flock of twenty or more (one very light colored) were going through a strange performance about two hundred yards offshore. With the exception of four or five at one side they were in a mass, half with their huge wings spread over the water, heads extended far forward, and tails erect and fanned out. They were constantly fighting in a clumsy manner with wings and bills. Every few minutes one would leave the group and, after flying about a while would return, and, assuming the above posture be assailed by the rest returning the blows with great energy.

On January 11, a bird killed on the water was torn to pieces by another of its kind before it reached the shore to be retrieved.

HALOBAENA MURPHYI, sp. nov.

Type.— Adult unsexed, M. C. Z. 70,725. Stromness Bay, South Georgia, collected during the summer of 1913. Collector not known. The type was presented to me by a storekeeper in the customs service at Port Stanley who had resided at South Georgia, and had kept this skin with a miscellaneous collection of curios.

Characters.— Similar to *H. caerulea* with the exception of the bill which in *murphyi* is much smaller, less slender, and wider at the base in proportion to its length.

Measurements.— Type, adult: wing, 212; tarsus 31; bill, 25.

I take pleasure in dedicating this new species to Mr. Robert Cushman Murphy whose recent studies of Tubinares have contributed so much of value and interest to our knowledge of this little-known group.

PETRELLA CAPENSIS (Linné).

Cape Pigeon.

Abundant about the steamer a day's steaming north of Port Stanley on October 3.

DIOMEDEA EXUANS Linné.

Wandering Albatross.

Two were noted on October 3, a day's run north of Port Stanley. On entering the Pacific from the Strait of Magellan on March 16, 1916, a dozen followed us for two days north in a heavy gale, leaving the day before we anchored at Coronel.

DIOMEDEA MELANOPHRYS Boie.

Mollymauk.

Several of these birds were seen on September 6, at 20 degrees S. not far from the Brazilian coast, and also between Montevideo and Port Stanley during the first week of October.

They breed in the western part of the Falkland group where I was unable to go, and are to be seen in small numbers flying off any shore.

During the latter part of February they were seen between the Falklands and the Strait of Magellan, and through the entire straits but not entering the Pacific where only *D. exsulans* was observed.

STERNA HIRUNDINACEA Lesson.

"Split-tailed Gull".

These terns are locally common, colonies to my knowledge being at Darwin, also on a small inaccessible island off Port Stephens, and a tremendous host on a tussock-island near Speadwell Island.

LARUS GLAUCODES Meyen.

"Fork-tailed Gull".

This beautiful little gull is moderately common on these islands.

They colonized close to the terns at the localities mentioned above.

Dr. Wace of Darwin informed me that these gulls in that vicinity fed largely on organisms found in the littoral fringe of kelp.

The fleshy eye-ring is bright red in life.

LARUS DOMINICANUS Lichtenstein.

Dominican Gull; "Big Gull".

Dominican Gulls are abundant and are great scavengers. About Port Stanley large flocks are to be seen in the yards of the slaughter-houses where they subsist upon offal. Elsewhere they may be seen coursing low over the land in search of dead cattle or sheep. I have seen them over a mile from the nearest water feeding on a dead cow. Shepherds told me that recently some of these gulls have acquired the habit of picking the eyes out of living sheep that have rolled upon their backs, and are unable to rise. They also feed on penguin eggs.

They are very pugnacious about a carcass, the adults fighting among themselves and driving off the immature birds, the latter daring only to fight other young birds. The young in fighting make more of it; pursuing each other, or facing about and sparring like young domestic cocks.

These birds have the laughing call of *L. marinus*, and a cackling cry of defiance that is always heard when they are squabbling about a carcass.

Dominican Gulls were noted more or less from the Strait of Magellan to Payta, Peru, where a small band fed about the ship on March 30, 1916. This is, I believe, a northern record.

One night while watching these birds settling to roost astern of the steamer at Punta Arenas it seemed strange that such creatures knew to some extent upon leaving the water what they were going to do. When a gull rose clear of the water and had ceased the more rapid initial wing strokes, if its legs were dangling it would not extend them behind and would only fly a few yards. If on clearing the water the legs were immediately extended back one could be assured that a more or less prolonged flight would be taken.

LEUCOPHAEUS SCORESBYI (Traill).

Scoresby's Gull; "Dolphin Gull".

This striking little gull would without the handicap of size be quite as predacious as the Dominican Gull. They do not course back from the water over the 'camp" as much as the latter, but all offal near the shore is eagerly sought. About the penguin colonies they are ever on the watch for eggs, and what semidigested food the penguins vomit.

They are very curious and large flocks will follow one along the shore, hovering just above one's head uttering their harsh "kee-uk, kee-uk" in a maddening way. At such times relief can be obtained only by shooting one of their number, and while the rest hover about to see what has befallen their comrade, one may make good one's escape from their annoyances.

CATHARACTA ANTARCTICA (Lesson).

Antarctic Skua; "Sea Hen".

This is a common bird on these islands, though none chanced to breed at the localities where I was stationed.

They are great scavengers about the offal from slaughtered sheep.

and their fondness for the eggs and downy young of penguins is well known.

They are very aggressive and often when no nests are in the vicinity one or more skuas will circle about and swoop at one's head, though only once was my head touched. However once was enough and thereafter I would kill any bird taking liberties with me in this manner. One cannot have a specimen exposed on the ground but what a skua will begin tearing it to pieces as soon as one has walked away a few yards.

CHIONIS ALBA (Gmelin).

Snowy Sheathbill; "Kelp Pigeon, Snotty Beak".

I only saw these extraordinary birds on two occasions, October 10, and 17, shortly after which and before I obtained permission to collect specimens they had disappeared, for the south no doubt.

On the wing they suggest very strongly a pigeon or rock ptarmigan in winter plumage.

Singularly tame they will approach within a few feet of a person standing on the beach and walk about gazing at one curiously.

Those I saw were quite quarrelsome among themselves and often three or four would form a small circle and after a brief period of bowing to each other would start a fight, the usual method being by means of hard blows administered with the wings.

HAEMATOPUS LEUCOPUS Garnot.

"Black and White Curlew".

Almost every stony beach has a pair or more of oyster-catchers residing there, for in the Falklands they prefer in most cases stony to sandy beaches.

Early in October the eggs, two in number, are laid in a slight cavity among loose stones and sand situated from a few feet above high-water mark to fifty or seventy-five yards. Fresh eggs were found on October 10, and on the same date a set was taken in which incubation had started.

The sitting bird leaves the nest at a signal from its mate on the beach before one is within a hundred yards of the nest. Sometimes the birds feign broken wings, at other times they walk slowly about close at hand with the tail pointing upward and the tip of the bill almost touching the ground. Often they will circle about with a peculiar nervous flutter.

Their antics at times are very amusing. Two or three pairs will join and with necks stretched out, bills pointed to the ground at right angles to the neck, and tails erect they will bob around and around in a small circle for a minute or two all the while giving their loud single call.

This species has much more individuality than the next which is a quiet stolid bird, and not in the least noisy or excitable.

HAEMATOPUS QUOYI Brabourne & Chubb.

"Black Curlew".

The less common of the oyster-catchers. I found no nests, and was told they nested about a month later than *H. leucopus*.

They, like the others, are more common about pebbly beaches, and so far as I could observe feed to some extent on limpets.

I never heard them make any noise whatever, and the other species is seldom quiet.

ZONIBYX MODESTUS (Lichtenstein).

"Dotterel".

This beautiful little plover is abundant everywhere during the summer frequenting the dry "camp," and "Diddle-dee" bushes even to the hill tops. At this season they are never on the beaches.

I was unable to find any eggs which are laid in early October. A downy young was taken on January 23, a very late date as young able to fly were taken on December 19.

The mournful call of the Dotterel is one of the most characteristic sounds of the "camp" where sounds are few, save the almost constant bleating of sheep. Everywhere one hears the plaintive "Quee" of this plover as it stands bobbing on a bunch of "Diddle-dee" bush. On the wing it utters a "Quee-ru," the accent on the first syllable, a very pretty call; at times a nervous "Crée-a-crée-a-crée-a" is given.

The downy young taken at Port Stephens, West Falkland, January 23, 1916, M. C. Z. 70644, orig. no. 1310 is colored as follows: —

Crown and back buffy white irregularly streaked with black; considerable rufous on the rump. Hind neck rufous. Forehead white, lores black, with a black line on the cheek becoming more narrow and extending to the sides of the neck. Wings black and buff. Throat and underparts white.

CHARADRIUS FALKLANDICUS Latham.

Double-ringed Plover.

The Double-ringed Plover is not nearly as abundant as the Dotterel. Although not on the beaches until late in December its range on the "camp" is close to the shore, never so far back as the other plover.

No nest was found, but downy young were seen and taken during the latter part of October. When seen they are more prone to run about instead of lying motionless as our northern shore birds prefer to do.

One of these young taken at Port Stanley, October 24, 1915, M. C. Z. 70628, orig. no. 1018, affords the following description: — Upper parts vinaceous buff irregularly streaked and spotted with black, wings and thighs the same. Under parts white with two indistinct sooty bars on the breast and lower throat.

Immature birds able to fly were taken at Port Stephens on December 3.

This plover is very quiet, rarely uttering its single note.

PISOBIA FUSCICOLLIS (Vieillot).

White-rumped Sandpiper.

Eight White-rumped Sandpipers were seen near Port Stanley, four on October 18, and the same number on October 21. Six were taken.

GALLINAGO PARAGUAIAE (Vieillot).

Patagonian Jack Snipe; "Snipe".

This snipe is quite common locally, breeding in October. Besides frequenting the low moist valleys they are often found on the uplands where some of the most treacherous bogs are to be found.

NYCTICORAX CYANOCEPHALUS FALKLANDICUS Hartert.

Falkland Night Heron.

Only a few Night Herons were noted. They were either flying along the shore or roosting upon exposed rocks on the cliffs or beaches.

CHLOËPHAGA HYBRIDA MALVINARUM Phillips.

Auk, Oct., 1916, **33**, p. 423–424.

"Kelp Goose".

The Kelp Goose is one of the most handsome geese in existence, and is a common bird on the Falklands.

They nest later than the other geese, and do not retire so far from the shore.

They are very tame, allowing one to approach within a few yards. The female is the first to show any alarm, a single male being almost as tame as a domesticated goose. When the female becomes nervous she utters a harsh "Uh-húh-uh-húh-uh-húh" with a rising inflection if repeated rapidly. The male's only call is a thin feeble "Seep-seep."

They seldom go into the water, and do not often fly. On one's approach they will run along the rocks or beach a long distance before taking to the water. If a dead bird falls into the water its fluffy plumage becomes more water-soaked than any species of goose I have killed.

It seems to be a general belief that this species feeds upon molluscs and other marine animals. Such is not the case in these islands, where its chief food is a thin filmy alga that grows on the rocks and is exposed at low tide. By the middle of December a large pulpy berry growing on a low vine becomes ripe, and of these the Kelp Geese are very fond. They never go more than about fifty yards inland in search of these berries.

The downy young are a dirty white.

At one time the snowy breasts of the males were sold in considerable numbers in London, but this traffic has become illegal.

Chloëphaga magellanica (Gmelin).

"Upland Goose."

This stately goose is abundant throughout most of the islands. They are in most instances very tame always allowing one to approach within easy gunshot.

The call of the male is very similar to that of the Kelp Goose. The female has a variety of calls, the most striking being a loud, resonant "Ca-rr′r-ca-rr′r-ca-rr′r" suggesting our *Branta bernicla glaucogastra.* At times it utters a series of cacklings, and its repertoire includes several indescribable notes.

They nest during October in the grass or "Diddle-dee" bushes, and along valleys, the male always in sight of the nest. The only set in my collection consists of six eggs taken November 3, and about one quarter incubated.

The first downy young were seen on November 7, and from that date until the twentieth of the month. The latest were noted December 29.

The broods averaged five or six young. Most of these newly hatched young instead of lying motionless until danger has passed will run about after their parents making themselves as conspicuous as possible.

The female shows the greatest concern when one is near the young. First she will run about with wings spread close to the ground until one is beside the young. Then she walks slowly about in a circle a few paces distant all the time giving a low "cluck."

The male though obviously disturbed is less courageous and walks about some distance away, nervously pecking at old dead grass-stems and whistling softly, but watching the disturber very closely. On one notable occasion the male outdid its mate in boldness. I was approaching a brood very closely, and at the same time focusing my graflex camera, when the male sprang up, and lighting on my head, gave me such a beating with its wings that my ears rang for some time. I eventually took a very good photograph of the whole family.

They begin to moult late in November about a month before the Kelp Geese. By mid-December large flocks take to the water.

Throughout the year Upland Geese feed upon tender young grass, especially during the spring and summer. This diet is varied in the autumn and winter by the consumption of berries locally known as "Diddle-dee" and "Malvina" berries. At this time they become very fat, and, roasted form a welcome change from the eternal diet of mutton.

Their habit of eating great quantities of succulent grass interferes with the nourishing of sheep upon which the colonists depend for a livelihood. Most of the sheep stations offer a bounty of so much per hundred bills brought to the managers, and this destruction should in time greatly reduce the numbers of these birds.

CHLOËPHAGA RUBIDICEPS Sclater.

"Brant."

Locally common, and abundant about Darwin and a few other places.

Except for a few seen on Speadwell Island, I only came upon ten, six at San Carlos, and a pair with two half-grown young on December 29, at Port Stephens.

I was told that their habits and calls were very like the Upland Geese. Where their numbers are great, bounties are offered for their beaks.

A male in good condition weighed exactly four pounds.

None of eight adults taken showed any white on the abdomen.

ANAS CRISTATA Gmelin.

"Gray Duck".

The Gray Duck is common, pairs being scattered along the protected beaches almost anywhere.

No nests were found. The first brood of downy young was seen at San Carlos on November 19. From that date to February 8 newly hatched young were noted.

Males weighed from $2\frac{3}{8}$ to $2\frac{5}{8}$ pounds and females about half a pound less.

NETTIUM FLAVIROSTRE (Vieillot).

"Teal".

This teal is fairly common, breeding along the small streams and creeks.

Downy young were found on November 7 at San Carlos, and half-grown birds in the same vicinity on November 19.

TACHYERES CINEREUS (Gmelin).

"Loggerhead Duck".

This is a very abundant duck in the Falkland Islands, and is to be seen everywhere on both exposed and protected beaches.

There is no doubt in my mind that there are both flying and non-flying Steamer Ducks, but how they are to be satisfactorily separated and diagnosed remains a task as yet unaccomplished.

C. C. Abbott writing in the Ibis, 1861, p. 162, says "the flying Loggerhead is not uncommon in the Falkland Islands," and considers it worthy of separation setting up the name *T. patachonicus* of King.

I spoke with many people in these islands and they all mentioned a flying bird that they called a "Canvas-back," which they have seen fly from the nest. Their only diagnostic character seemed to be a lighter color. An old male taken at Port Stephens, January 17, orig. no. 1289, apparently unable to fly, was identified by the residents as a "Canvas-back," my attention being called to its lighter color. It seemed to me that it was merely an old grizzled bird, its skeleton, and larynx giving every evidence of old age. It is a large bird and the wings as small in proportion as on any other.

It was not my good fortune to see any of these ducks flying, though many when frightened could raise the body clear of the water except the feet. From this state of very nearly flying, one sees even in a single flock every stage to mere flapping. The wings are less often used as paddles, the birds generally managing to keep the forepart of the body off the water, and pulling themselves along.

Mr. F. E. Blaauw (Ibis, July, 1916, ser. 10, **4**, p. 488–492) discusses these two forms, and though he may have settled this question as regards birds in Terra del Fuego, and the Strait of Magellan he has proved nothing regarding this species in the Falklands.

He states (p. 491) that *T. patachonicus*, the flying duck is smaller than *T. cinereus*, and the bill is orange-yellow. The plumage is bluish gray, with a white breast and belly, and a white wing-speculum.

The female *patachonicus* (p. 491) is smaller, head brown, rest of the body except the white underside and white wing-bar, of a wine-color, with gray centres to the feathers of the upperside and sides. The bill is brown or black.

T. cinereus according to Mr. Blaauw (p. 489) is "enormously big." "Both sexes when adult are grey in this species, with a white underside, and a white wing-speculum. The male is the lighter colored of the two, and has a lighter head.

The bill in both sexes when adult is orange-yellow . . . . ."

Among many hundreds of these ducks seen in the Falklands, all, except perhaps in size (Mr. Blaauw gives no measurements) answer absolutely his description of what he diagnoses as *T. patachonicus.* No birds of dark plumage, the females, even had yellow bills, and no females were seen in anything that could possibly be referred to as a gray plumage. And out of many hundreds seen none took flight, although I do not doubt for an instant that a small percentage can fly.

This duck like so many other birds in these islands is very tame, especially in the harbor of Port Stanley.

They are quite curious, often swimming near if one sits quietly on the beach. If anything disturbs a flock others will swim up to see what caused the commotion.

The call of the female is a hoarse, rasping sound that can be heard a considerable distance. The male's thin, wheezy "Kée-u-kée-u-kée-u" sounds more like a sneeze than anything else.

Like the penguins they can go through the most heavy surf, but often harder work is made of it.

Nesting begins early in October, the nest being placed in grass, ferns, or "Diddle-dee" bushes, as far as half a mile from the sea.

The first downy young were noted on November 16, and from this date until December 26, new broods were seen, the largest containing seven. At this time the parents are very wary and at the distant approach of man swim a long distance from shore with the brood. The young immediately upon hatching are able to dive and swim well under water.

Adults are fond of feeding in shoal water along the stony beaches, where they dip like "river ducks." They make an unusual amount of noise when diving, and on a still evening the splashes suggest the rising of trout in some northern "still-water."

Their food includes all manner of small marine animal life. A single stomach dissected contained limpets, small chitons, mussels, various gasteropods and bivalves, shrimps, and two species of crabs, the carapace of the larger being two inches long by one inch wide which with its legs must have been a large object to swallow.

The weight of Loggerhead Ducks has been greatly exaggerated by old writers. Captain Cook claimed that they weighed twenty-nine or thirty pounds. Coppinger in the cruise of the ALERT, 1883, found fourteen pounds to be the heaviest. This is reasonable although my heaviest male taken at a season when birds are not very fat weighed only nine and one half pounds.

PHALACROCORAX MAGELLANICUS (Gmelin).

"Rock Shag".

The Rock Shag is very abundant and seen everywhere along the coast.

PHALACROCORAX ALBIVENTER (Lesson).

"King Shag".

This cormorant was very abundant especially in Falkland Sound.

CATHARTES FALKLANDICA (Sharpe).

"Turkey Buzzard".

Turkey Buzzards are common in many places though they are killed whenever possible.

Four pence per bill is paid owing to a recent habit they have formed of eating the eyes and tongues of sheep that have rolled upon their backs and are unable to regain their feet on account of their heavy wool.

POLYBORUS PLANCUS Miller.

"Carrancho".

The Carrancho is now an uncommon bird near the settlements owing to its being shot at every opportunity. It, like the Buzzard, attacks helpless sheep eating the eyes and tongues, only it is more aggressive. Sixpence bounty is offered for each bill.

They are naturally very wild, perching upon rocky pinnacles from which one's approach can be seen for a great distance. Their rolling call is not unpleasant to hear, and suggests our Northern Raven.

BUTEO POLIOSOMUS (Quoy & Gaimard).

"Blue Hawk".

This is no longer a common bird, although Abbott (Ibis, 1861, p. 151) mentioned it as common. I noted but one pair.

FALCO PEREGRINUS CASSINI Sharpe.

"Sparrow Hawk".

This falcon is rare and killed whenever opportunity affords owing to its daring and successful raids upon young poultry. It is very swift of flight and not easily shot.

Of two specimens in my collection, the stomach of one contained many feathers of *Muscisaxicola macloviana.*

CINCLODES ANTARCTICUS (Garnot).

"Tussac Bird".

During a few hours stop at Speadwell Island these birds were found abundant near the shore. They were very tame, and when I sat on the bank they would walk within three or four feet looking up at me curiously with their black beady eyes.

They are rare birds on the main islands, preferring the outlying tussock islands.

MUSCISAXICOLA MACLOVIANA (Garnot).

"Blue Bird".

This long-legged little tyrant-bird is common, the majority being found about the "stone rivers," where they prefer to nest. It is a difficult task collecting specimens on these "rivers" for many of the boulders are merely balancing, and to travel without getting a bad fall and still keep an eye on the bird ahead as it flits about requires a great fund of patience.

Only one nest was found and this contained three newly hatched young on October 27. It was situated deep down among the rocks from which I had to remove many pounds of loose stones. The nest was quite large and well constructed of grass and moss, the lining being of feathers. The young were being fed on spiders.

Spiders are the chief food of these birds, and at Port Stephens a few were always found feeding upon wingless flies on the beach.

TURDUS FALKLANDICUS Quoy & Gaimard.

"Thrush".

Thrushes are common except near Port Stanley. Here the few thrushes to be found are upon the hilltops about the rocks. Elsewhere they were found near the shore, especially about patches of ferns in which they like to nest. The nests are sometimes in sheltered places in the rocks and occasionally in sheds like our own Robins. The nests are bulky and composed of grass.

At least two broods are reared in a season. A young bird able to fly was taken on November 3, and on the same day a nest containing three fresh eggs. An immature bird taken on January 12, has pin feathers of the first adult plumage.

The song is of the same type as our Robin but less vigorous.

ANTHUS PHILLIPSI Brooks.

Proc. N. E. zool. club, **6**, p. 26–27.

"Skylark".

This pipit is abundant on the Falklands.

It has certainly two, and perhaps three broods in a summer. A nest found on December 16 contained two young and two eggs about to hatch. The nest was small, and placed in a tuft of grass on a hilltop.

Like other species of pipits they are wild and restless birds.

PHRYGILUS MALVINARUM Brooks.

Proc. N. E. zool. club, **6**, p. 25–26.

The type of this strange finch is an immature bird.

PHRYGILUS MELANODERUS (Quoy & Gaimard).

"Cock Sparrow".

This finch is common, scattered about the grassy country from the valleys to the tops of the hills.

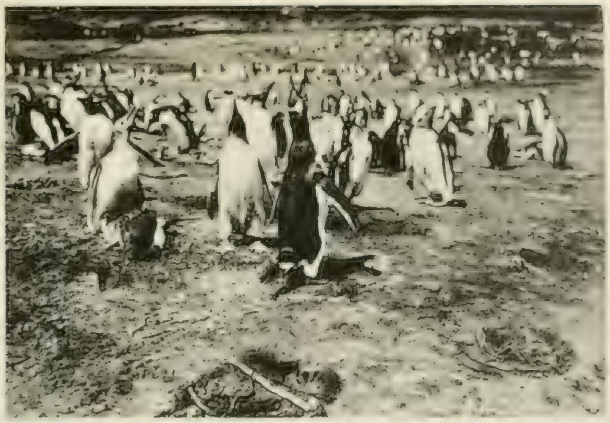
The song is a short, clear "Chée-ru."

TROUPIALIS FALKLANDICUS Leverk.

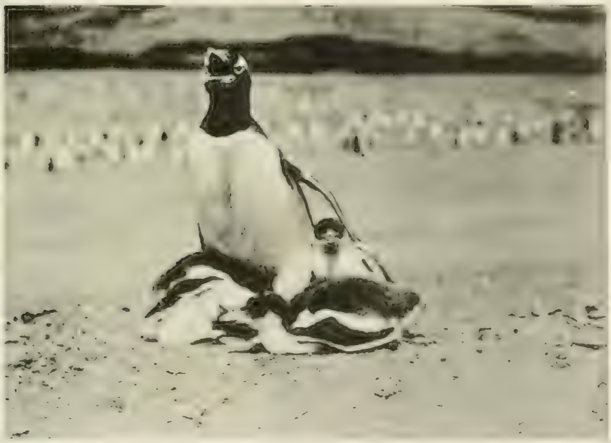
"Robin".

This beautiful bird is common but local in its distribution. They are the least tame of the Falkland Island land birds.

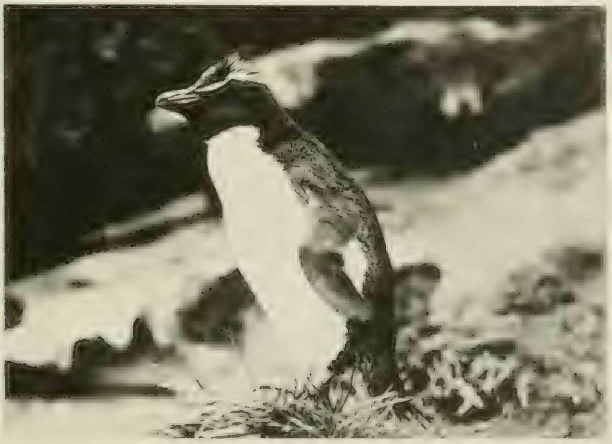
The song is a pretty, liquid "Tsee-tsee-tsoo-tsee."



PYGOSCELIS PAPUA (FORSTER), TRUMPETING, PORT STEPHENS, 11 JAN. 1916



PYGOSCELIS PAPUA (FORSTER), AND YOUNG, PORT STEPHENS, 21 JAN. 1916



EUDYPTES CHRYSOCOME (FORSTER), PORT STEPHENS, 5 FEB. 1916

HELIOTYPE CO. BOSTON.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LXI. No. 8.

EXPLORATIONS OF THE COAST WATER BETWEEN CAPE COD AND HALIFAX IN 1914 AND 1915, BY THE U. S. FISHERIES SCHOONER GRAMPUS. OCEANOGRAPHY AND PLANKTON.

BY HENRY B. BIGELOW.

WITH TWO PLATES.

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No. 8.— *Explorations of the Coast Water between Cape Cod and Halifax, in 1914 and 1915, by the U. S. Fisheries Schooner Grampus. Oceanography and Plankton.*

By Henry B. Bigelow.

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INTRODUCTION.

In 1914 the summer cruise of the GRAMPUS was planned to afford a general survey of the coast water, out to the 1000 fathom curve, from Cape Cod to Halifax.[1]

Sailing from Gloucester on July 18, the first section was made across the western end of Georges Bank, to the continental slope; we then ran eastward, along the southern and southeastern edge of the Bank, to longitude 66° 10′ w.; whence a second section was made across its eastern part, to the basin of the Gulf of Maine. The third section was from the eastern edge of the Bank across the deep Eastern Channel, the Northern Channel, and the coastal bank, to Shelburne, Nova Scotia.

On July 27th the GRAMPUS anchored some thirty miles off Shelburne, in thirty fathoms of water, and measurements of the surface current were taken hourly for twelve hours, covering an entire tide, ebb and flood (p. 203); with occasional readings on the bottom. We then ran offshore once more, via Roseway Bank and the basin southeast of it, to the continental slope in longitude 63° 58′; thence to Halifax. With orders to return to United States waters, owing to the European war, the GRAMPUS, on August 6th, sailed southward as far as the southwestern edge of Emerald Bank, then westward, toward the Gulf of Maine, via Shelburne.

Locating the Gulf of Maine stations at the same positions as those of 1912 and 1913 (Plate **1**), the GRAMPUS proceeded from Woods Hole, across the continental shelf to the edge of the Gulf Stream; making two successful sets of the long trawl for Tile fish, in 80 and 105 fathoms. The catch at the latter was nineteen fish, with an aggregate weight of about 350 pounds. On August 28th the GRAMPUS returned to Gloucester.

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[1] For a summary of the Cruise of 1914, see Bigelow, (1914c).

From May to October, 1915, the GRAMPUS was employed in an investigation of the Herring in the Gulf of Maine, and with oceanographic cruises (Plate **2**). Between May 4th and 14th lines were run from Gloucester across the Gulf to German Bank and Yarmouth, Nova Scotia; thence to Mount Desert Island; and along shore back to Gloucester. During the last half of June we made sections from Boothbay, Maine to Cape Sable; Shelburne, Nova Scotia, to the continental slope; thence via Brown's Bank, the Eastern Channel, and the southern half of the Gulf of Maine, to Gloucester.

On August 31st the GRAMPUS once more sailed from Gloucester to Cape Sable and Shelburne; thence, after making two stations off Shelburne, to Eastport, Maine. In October two sections were run across the mouth of Massachusetts Bay; and a partial one from Woods Hole, south across the continental shelf. Besides these oceanographic cruises, other stations were occupied, along shore, during the fisheries investigations (Plate **2**), notably one in the Bay of Fundy Deep, a locality not visited previously. Details of the stations are tabulated below (p. 330).

During 1914 and 1915 complete oceanographic records were taken at 126 stations; 311 tows made with the horizontal, 76 with the quantitative nets.

The equipment of the GRAMPUS (Bigelow, 1915, p. 154) has been much improved since 1913, the old deep-sea thermometers having been replaced by a set of thermometers of the latest type, our stock of stop-cock water-bottles increased to six, and the thermometer frames attached to the water-bottles, allowing the two sets of instruments to be operated simultaneously. We also used an Ekman reversing water-bottle, the instrument generally employed by European geographers. But it proved far less reliable than the stop-cock bottles, often failing to close when there was any stray to the wire. The ship carried three Ekman current-meters, and a Lucas sounding machine. The set of plankton-nets comprised large and small horizontal tow-nets of fine and coarse silk; meter-nets for horizontal work of stramin, Helgoland nets of fine and coarse silk and of stramin; meter-nets of netting and silk of the MICHAEL SARS pattern (Murray and Hjort 1912, p. 46), a Peterson young fish-trawl; and quantitative nets. The usual fishing gear and harpoons were also carried; in short, a thoroughly modern oceanographic outfit.

The general program for each station consisted of a set of serial temperatures and water-samples, at 3–7 levels according to the depth, and repeated in case of any apparent discrepancy; a vertical haul with the quantitative net,[1] especially for copepods; surface hauls with the fine (no. 20 silk) and coarse (no. 5 silk) nets for microplankton, copepods, etc., and fish eggs; and hauls at intermediate depths with the Helgoland, and other horizontal nets. The number of the latter depended on the depth, the nets being usually attached simultaneously to the wire at the desired levels. The surface temperature was recorded hourly throughout the cruise. On the only occasion when current measurements were taken (p. 203) the ship was anchored for the purpose.

For the identification of specimens thanks are due to Dr. W. M. Tattersall (euphausiids); Dr. C. O. Esterly (copepods); Mr. W. F. Clapp, (pteropods and heteropods); Mr. W. W. Welsh (young fishes); Mr. L. Radcliffe (fish eggs); and to Dr. Johan Hjort for assistance in preparing some of the profiles.

OCEANOGRAPHY.

Temperatures and Salinities in 1914.

The records for 1914, covering as they do the whole breadth of the continental shelf, and all being taken in a month's period, justify the description of the hydrography of that summer in some detail.

Surface Temperature.— The surface temperature (Fig. 1) of the southern and western parts of the Gulf of Maine was about the same in 1914 as in previous years, (15°–18°), with a band of distinctly colder water, (11°–15°), along its northern and eastern shores, including Brown's Bank, the minimum being 6°, some thirty miles off Cape Sable. The warm surface, (18°–20°), noted off Cape Cod in 1912 and 1913 obtained there in 1914 also: apparently, then, this phenomenon is normal; and this year we were able to demonstrate, what previously was supposition only, that this warm area was separated from the still warmer Gulf Stream by lower temperatures, (11°–15°), on Georges Bank. Along the southern edge of the latter the influence of the Gulf Stream is evidenced by the warmer surface (18°–20°). Judging from the previous year the 20° curve probably followed the 200 meter contour as far west as Longitude 70°, in July. But by the end of August a surface temperature of 20° was found within fifteen miles of Marthas Vineyard. The very cold water off Cape Sable, noted above, was only a local phenomenon, associated no doubt with vertical currents, for the temperature was higher (10°–12°) along the southeast coast of Nova Scotia.

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[1] In 1914 the quantitative nets were of the HENSEN pattern (Johnstone 1908): in 1915 these were replaced with nets of the MICHAEL SARS pattern, one half meter in diameter of mouth.

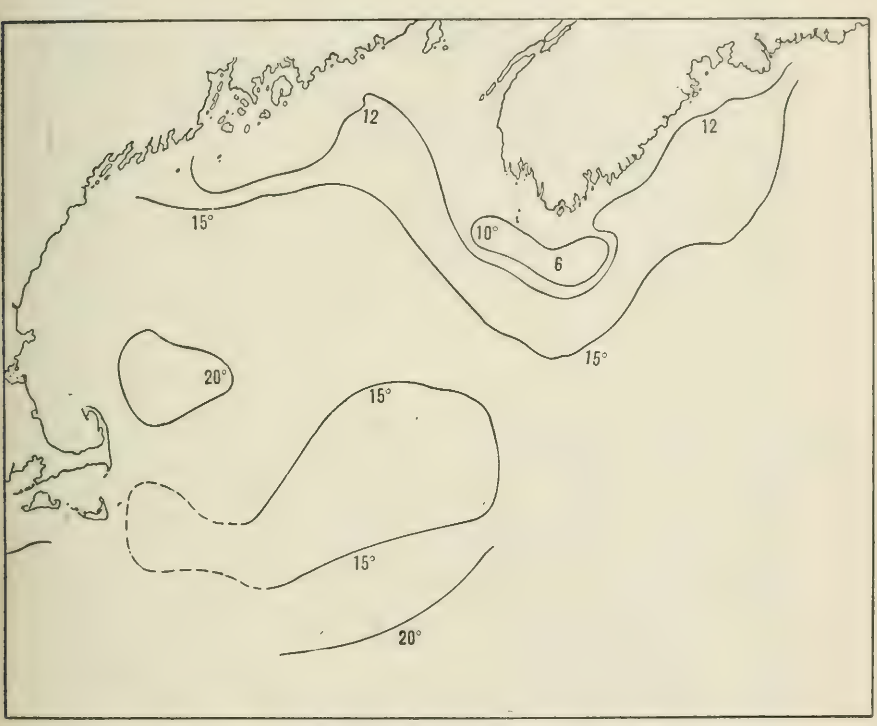

Fig. 1.—Surface temperature, July–August 1914.

Temperature Sections.— Temperature and salinity sections are chiefly interesting as the basis for the profiles, and charts for different levels. The temperature curves for the Gulf of Maine are of the same general types as in 1913 (1915). Thus both in the eastern and in the western basins the water was coldest in the mid-depths (about 100 meters); down to which level vertical cooling was very rapid at all the deep Gulf stations, most so in the western part (Fig. 2).

In the sink east of Cape Ann (Station 10253), however, and the trough west of Jeffrey's Ledge, the temperature was practically uniform, below the level of the enclosing rim. In the southeast and northeast parts of the Gulf, too, and in the Eastern Channel (Station 10227, Fig. 2), the water was coldest on the bottom, instead of in the mid-depths. In 1914 there was no exception to the rule that in summer the surface is progressively cooler and cooler, the bottom, depth for depth, progressively warmer and warmer, following the northern coast of the Gulf from Massachusetts Bay around to the Bay of Fundy, the vertical range of temperature decreasing from about 12° off Cape Ann, to practically *nil* in the Grand Manan Channel (1914a).

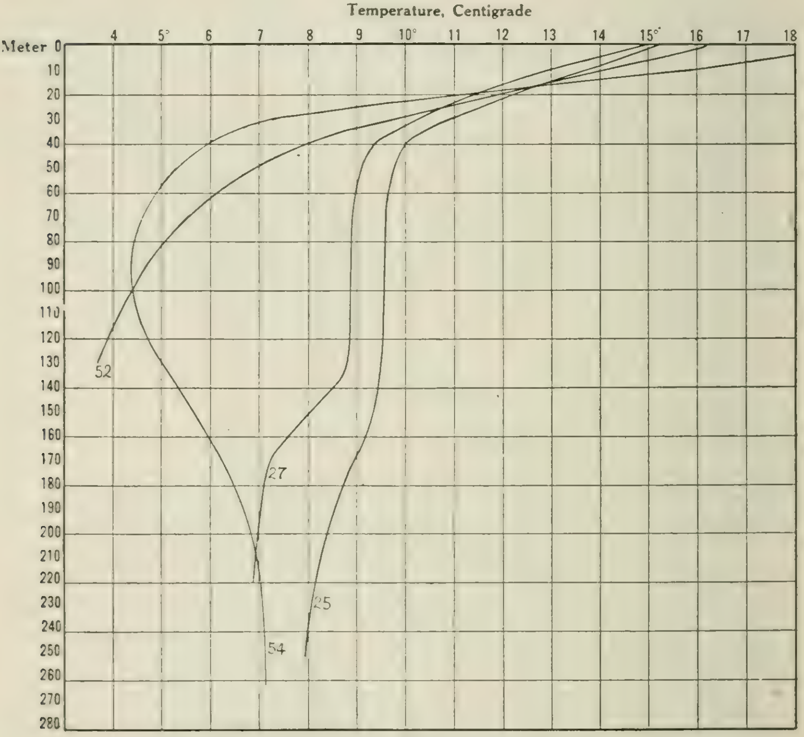

FIG. 2.— Temperature sections in the western (Stations 10252, 10254) and southeastern parts of the Gulf of Maine (Station 10225), and in the Eastern Channel (Station 10227), July 1914.

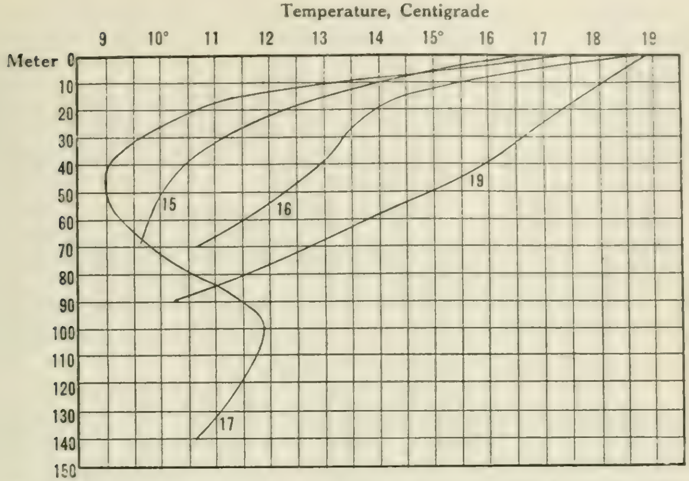

FIG. 3.— Temperature sections on the western part of Georges Bank, Stations 10215, 10216, 10217, 10219, July 1914.

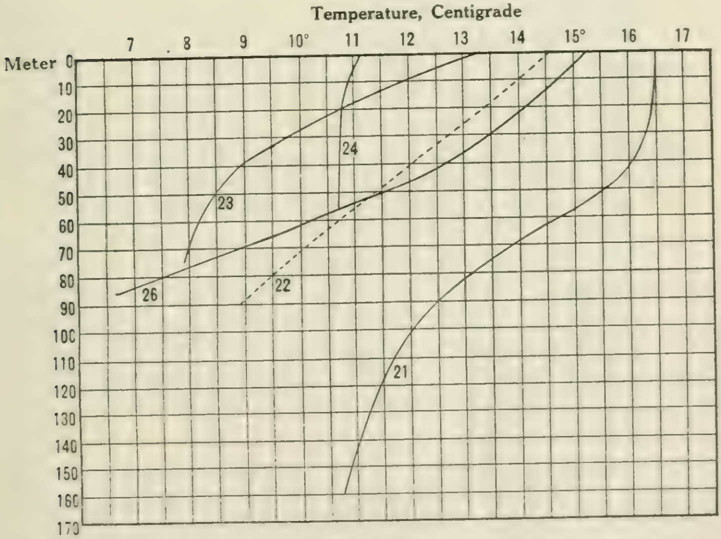

FIG. 4.— Temperature sections on the eastern part of Georges Bank, Stations 10221, 10222, 10223, 10224, 10226, July 1914. The curve for Station 10222 is approximate only.

On German Bank (Station 10244), likewise, the temperature was almost uniform (9.5°–10°) from surface to bottom, as in previous years (1914a, 1915).

On Georges Bank as a whole (Fig. 3, 4) the vertical range of temperature was considerable, with the water coldest on the bottom, and the rate of vertical cooling more uniform than in most parts of the Gulf (Fig. 2). But Station 10217, over the 150 meter contour on the southwest slope of the Bank is an exception to this rule, its minimum lying at 40–50 meters instead of on the bottom. Locally, on the northeast part of the Bank (Station 10224), the water was so thoroughly mixed by vertical circulation that the temperature was practically uniform

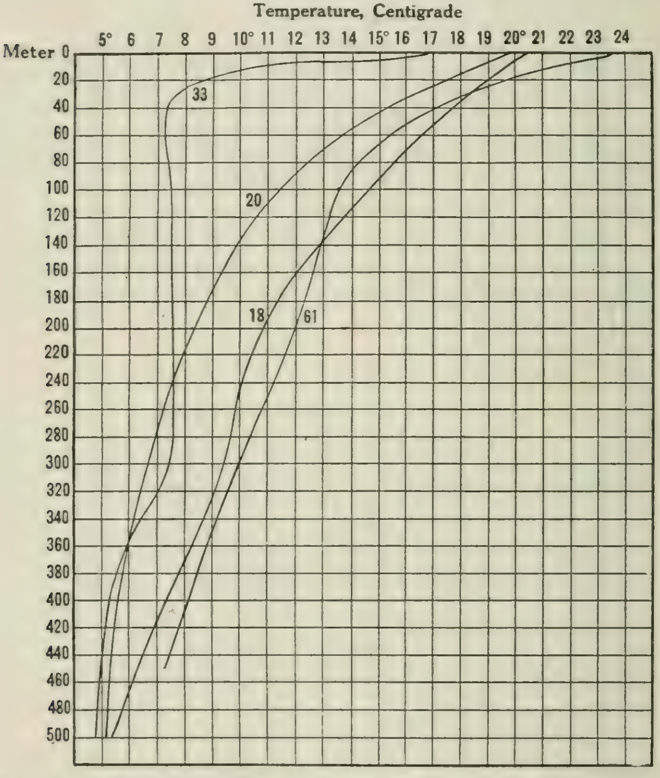

FIG. 5.— Temperature sections over the continental slope, Stations 10218, 10220, 10233, 10261, July–August 1914.

(10.5°–11°) from top to bottom; and this was probably the case elsewhere on its shallower and more broken parts, *e. g.*, near Cultivator Shoal, where the tidal currents are proverbially violent.

The two deep Stations (10218 and 10220, Fig. 5) off the southern face of the Bank are of the usual oceanic type, cooling at a decreasing rate, from the surface down to 500 meters. But while the two were about alike on the surface (20°), the water at 300 meters was 3°–4° cooler off the southeastern part of the Bank (Station 10220) than it was 100 miles further west.

On Brown's Bank (Station 10228, Fig. 6) the water cooled rapidly from the surface (14°) down to 40 meters (8.5°), below which level, the temperature was practically uniform down to the bottom. And this same type of curve is characteristic of the shoals south of Nova Scotia, *e. g.*, Le Have and Emerald Banks, and of a narrow zone near its southeastern coast, though the water there was much colder, the temperature being only 1.7° at 20–50 meters off Shelburne (Station 10231) and the bottom water, in 75–85 meters off Halifax (Stations 10236, 10237, Fig. 6) even colder (.76°–1.1°). The Nova Scotian Banks (Stations 10234, 10240, Fig. 6) were likewise colder than Brown's Bank.

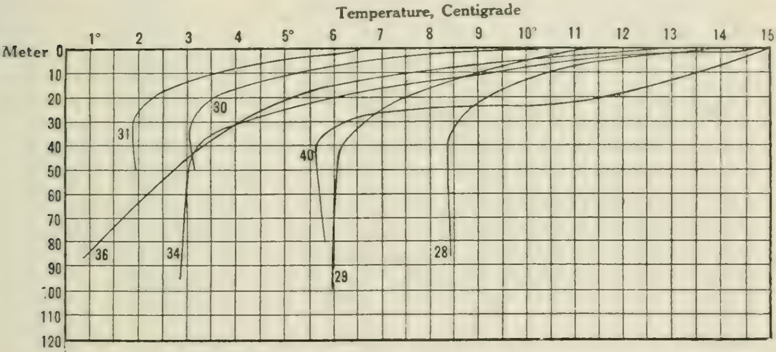

Fig. 6. Temperature sections on Brown's Bank (Station 10228), in the Northern Channel (Station 10229) and at the shallow Stations and Banks off southern Nova Scotia (Stations 10230, 10231, 10234, 10236, 10240), July–August 1914.

The temperatures in the basins south of Nova Scotia are especially instructive. At every station on this part of the shelf where the water was more than 100 meters deep, the temperature was lowest in the mid-depths, with warmer water below (Fig. 7). In the deep off Halifax, and on the edge of Emerald Bank, this warming was followed by a slight cooling close to the bottom. But in the basin north of Le Have Bank (Station 10235) the temperature rose continuously, from the minimum layer down to the bottom, a type of curve similar to the deep stations in the western and northern parts of the Gulf of Maine.

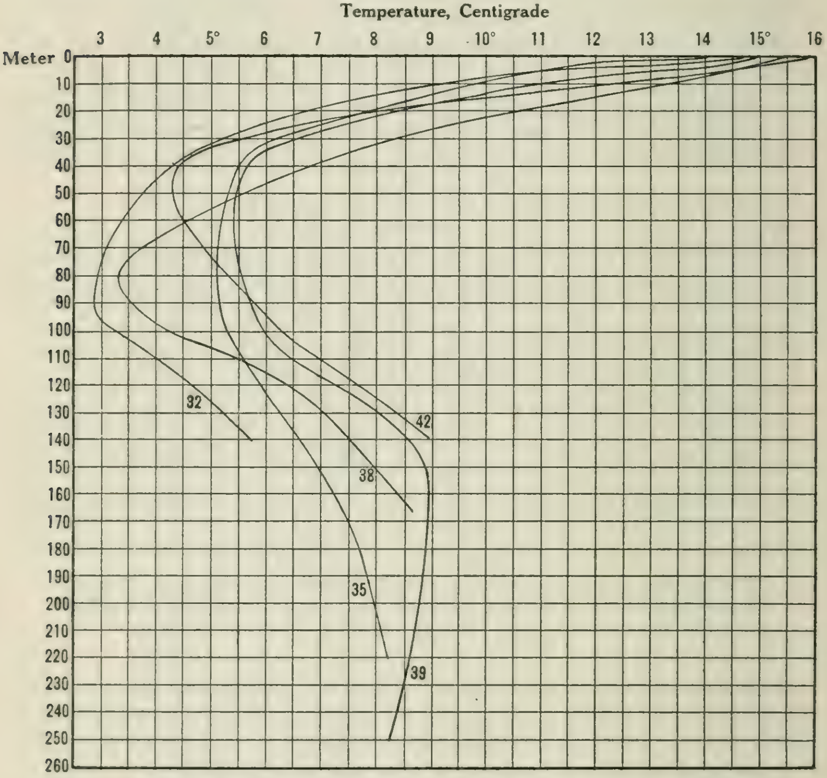

FIG. 7.— Temperature sections in the basins off southern Nova Scotia, Stations 10232, 10235, 10238, 10239, 10242, July–August, 1914.

The minimum temperature at these deep stations was lowest between Le Have and Roseway Banks (Station 10232, 2.8°); rising to about 5° in the basin off Halifax (Station 10239).

Station 10233 (Fig. 5) on the continental slope south of Nova Scotia is interesting because instead of showing the steady vertical cooling which characterized the stations at the same relative position further

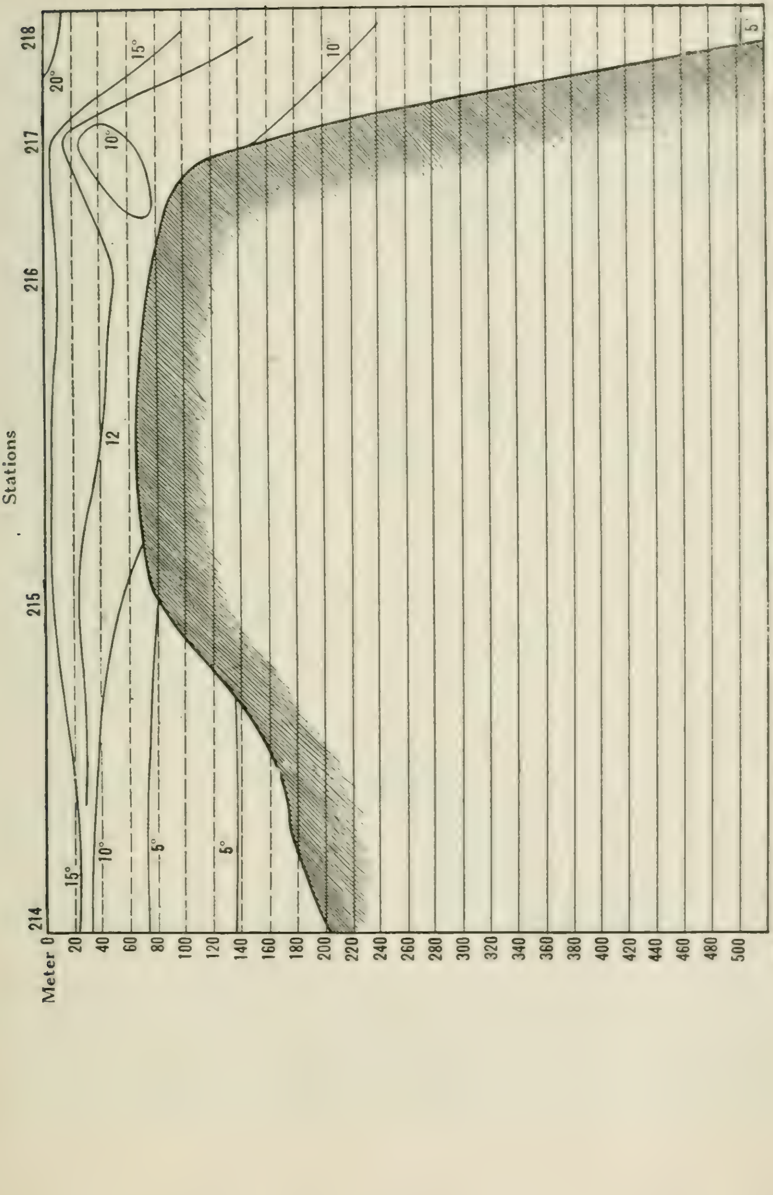

Fig. 8.— Temperature profile from basin of the Gulf of Maine (Station 10214) across the western part of Georges Bank, to the continental slope (Station 10218), July 1914.

west (Stations 10218, 10220, Fig. 5), the temperature was practically uniform from forty meters down to 300 meters.

The water was considerably warmer on the continental shelf south of Marthas Vineyard than anywhere in the Gulf of Maine, or off Nova Scotia.

Temperature Profiles.— The relationship of the water of the Gulf of Maine to the Atlantic water is illustrated by profiles across the west and east ends of Georges Bank. Thus the Western Basin of the Gulf, (Fig. 8), with its minimum of 4°–5° at 100 meters, was much colder at all depths than the water south of the Bank; for example to find water on the continental slope, as cold as the 100 meter-level in the Gulf, we must go below 500 meters; while 10° water lay at 40 meters in the Gulf; but only below 150 meters on the slope. And the surface water at Station 10218 was warmer than any water anywhere in the Gulf. But there is much less difference between the two ends of the profile across the eastern part of the bank, Gulf water being warmer here than further west (Fig. 9), ocean water colder (p. 171).

The two profiles, combined, reveal the existence of a clearly defined cool band (8°–10°), lying on the middle of the bank at its eastern, over the southern edge at its western end. And they are further interesting for their demonstration that the cold water of the Atlantic abyss (4°–5°), was separated from the bottom water of the Gulf of Maine by a much warmer zone (8°–10°) of bottom water; a phenomenon with which we are already familiar further south (1915), and one of great importance for its bearing on the origin of the Gulf water (p. 240). The profile running from Georges Bank to Cape Sable, via the Eastern Channel (Fig. 10) shows that the eastern side of the Channel was appreciably warmer than the western, below the level of its confining banks, though the waters over the latter were of about the same mean temperature on the two sides. But it is chiefly interesting for its illustration of the sudden change which takes place, east of Brown's Bank, from the moderate temperatures of the banks, and of the upper layers of the Gulf of Maine as a whole, to very much colder water next southern Nova Scotia.

This cold water, characterized by the almost polar temperatures of 1°–2°, extended in a continuous band along the coast from Cape Sable to Halifax (Fig. 11–13). And I may forestall the following discussion (p. 234) so far as to say that it is undoubtedly the product of the Cabot Current. In summer it is limited here to a narrow coastal zone; projecting thence outward like a shelf, along the 50 meter-level, into warmer water offshore. Thus on the Halifax line (Fig. 13) water

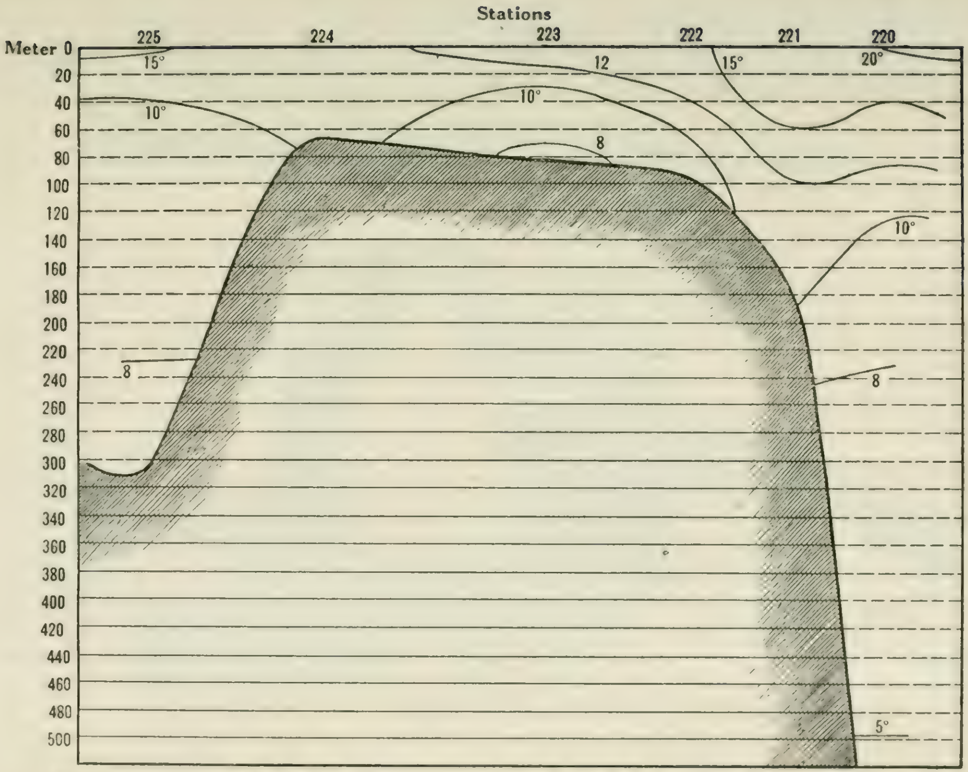

Fig. 9.— Temperature profile from the southeast corner of the Gulf of Maine (Station 10225) across the eastern part of Georges Bank, to the continental slope (Station 10220). July 22–23, 1914.

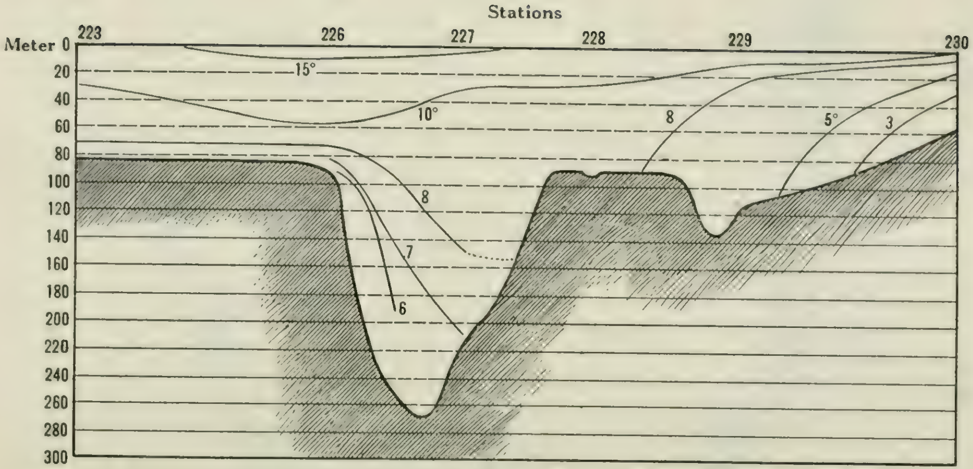

Fig. 10.— Temperature profile from the eastern part of Georges Bank (Station 10223) across the Eastern Channel, (Stations 10227), Brown's Bank (Station 10228) and the Northern Channel (Station 10229) to the neighborhood of Cape Sable (Station 10230). July 23–25, 1914.

colder than 2° hugged the shore closely; and off Shelburne it extended seaward only to Roseway Bank (Fig. 11). But on this line its effect was unmistakable much further offshore, reaching to Le Have Bank by an eddy-like movement (Fig. 12, 15); and the fact that the upper layers over the slope were much colder here (Station 10233) than off Georges Bank (p. 170), is probably also due to the influence of this frigid coast water.

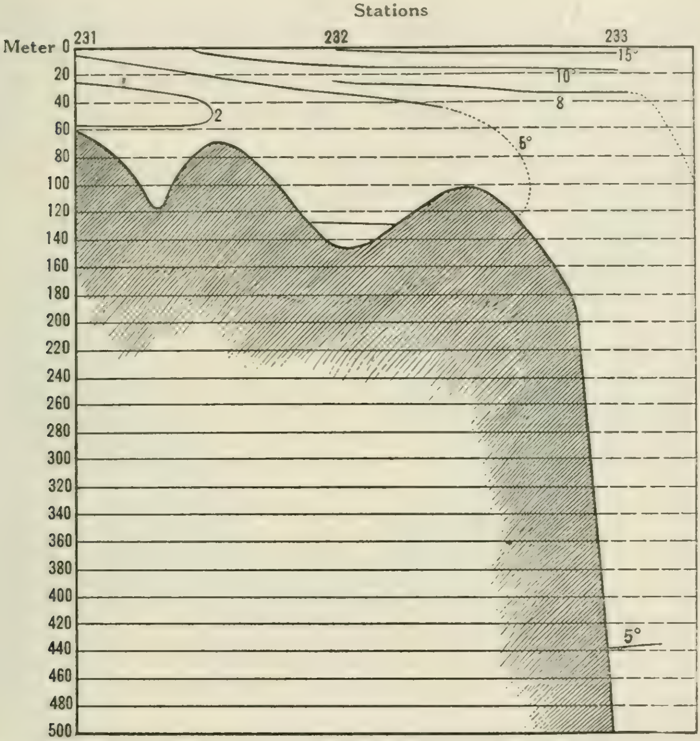

Fig. 11.— Temperature profile across the continental shelf off Shelburne, Nova Scotia (Stations 10231, 10232, 10233). July 27–28, 1914.

The profiles off Halifax (Fig. 12, 13) illustrate more graphically than do the temperature sections (p. 171) the contrast between the warm (8°) water in the bottoms of the deeps on this part of the shelf, and the colder water in the mid-depths.

The profile off Marthas Vineyard is sufficiently illustrated by Fig. 14; the only feature deserving emphasis being the cool water (9–10°) on the bottom between the 40 and 90 meter contours, and the fact that this is separated from the cold water of the abyss by a warmer zone.

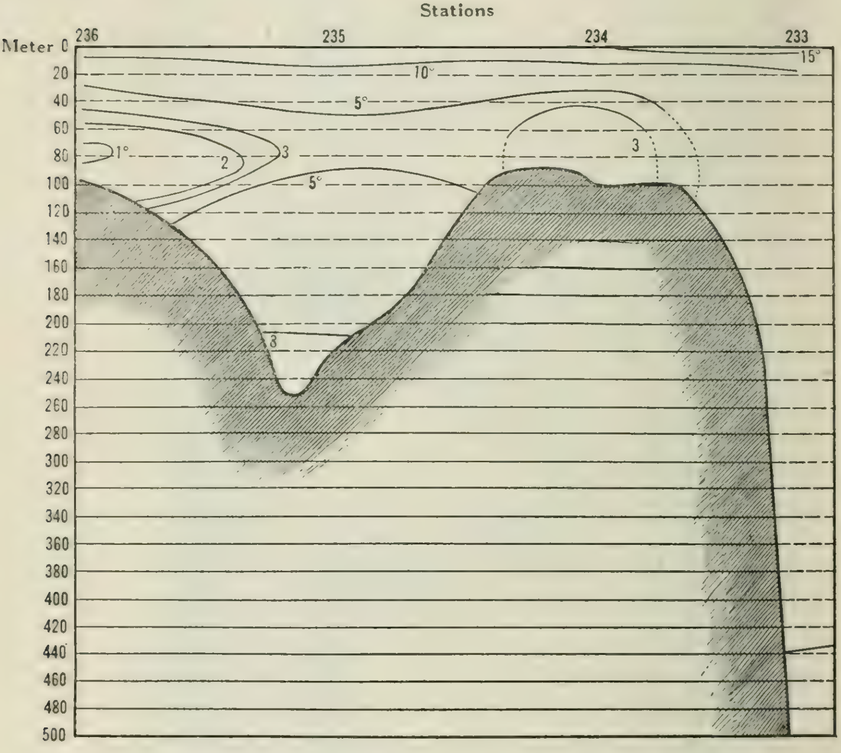

FIG. 12.— Temperature profile crossing the continental shelf obliquely off Halifax (Station 10236 – Station 10233) July 29–August 2, 1914.

Temperature at the 40, 100, and 200 Meter-levels.— The surface temperatures of our waters in summer are chiefly the product of solar warming, and local vertical circulation. But the penetration of solar heat being very slow, except close to the surface, temperatures at, and below 40 meters may be expected to throw more light on the origin and movements of the waters concerned.

The temperature charts for the 40 meter and 100 meter-levels show graphically how the frigid water off southern Nova Scotia is separated from the cool waters of the western part of the Gulf of Maine, by higher temperatures in its eastern half, the latter continuous via the Eastern Channel, with the warm waters outside the continental slope. And the curve for 8° at 40 meters, 5° at 100 meters shows that this comparatively warm water follows the northern coast of the Gulf westward, beyond Penobscot Bay. The coastal character of the cold water off southern Nova Scotia, and its seaward extension to and including Le Have Bank, appears even more clearly on the charts than in the profiles (p. 177). And they amplify the latter by revealing the presence of a tongue of much higher temperature approaching the land off Halifax, apparently an offshoot from the still warmer water outside the continental slope (Fig. 15, 16).

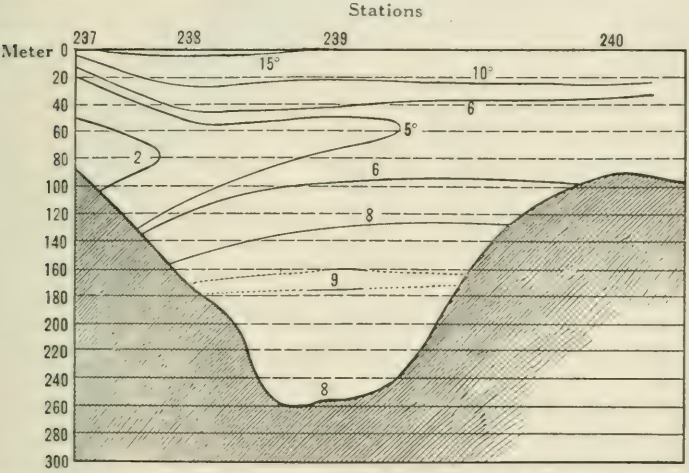

FIG. 13.— Temperature profile from Halifax (Station 10237) to Emerald Bank (Station 10240), August 6–7, 1914.

I need only call further attention, on the 40 meter chart (Fig. 15), to the cool (8°–10°) band already mentioned (p. 174) as dividing the warmer (10–12°) water of Georges Bank obliquely, from northeast to southwest.

The ocean area deeper than 200 meters, on the part of the continental shelf under consideration, is confined to the deep basins of the Gulf of Maine, to the Eastern Channel; and to two isolated basins south of Nova Scotia. The temperature was 6°–7° in the western basin of the Gulf, 8°–9° in its southeastern corner, 6°–7° in the Eastern Channel (Fig. 17), 6°–7° in the southern half of the Eastern Basin, in its northern half 8°. The two basins off Nova Scotia were likewise 8° at this level. Off the southern face of Georges Bank the 200 meter temperature was about 10°.

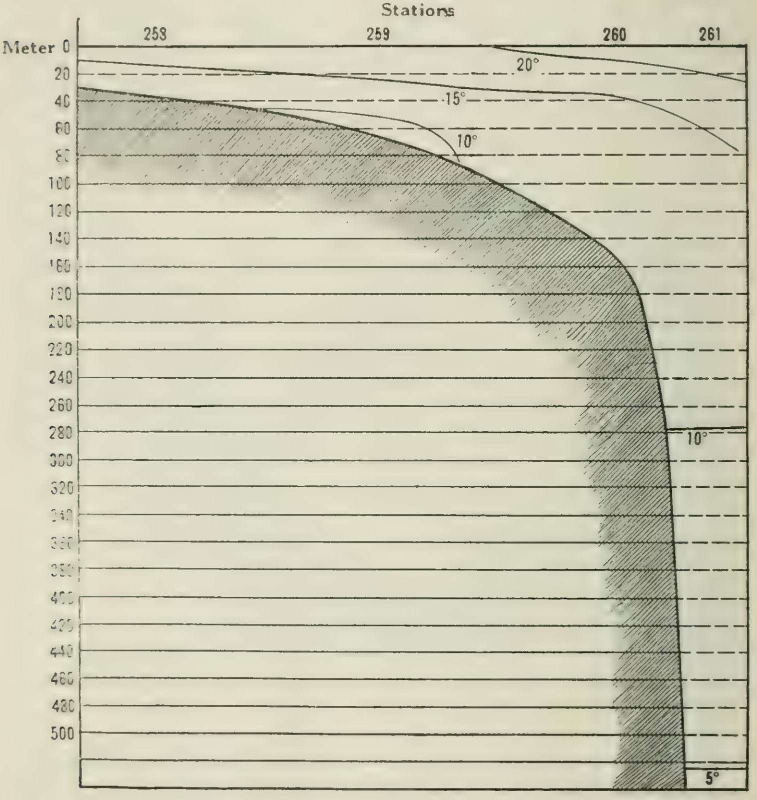

FIG. 14.— Temperature profile across the continental shelf south of Marthas Vineyard (Stations 10258–10261), August 25–26, 1914.

In the foregoing charts the temperatures off Marthas Vineyard have been omitted because taken so late in the season that they are not directly comparable with the others.

Surface Salinity. — Surface salinity being unaffected by solar warming, might be expected to reproduce in its main features, the temperatures at some little depth rather than the surface. And such is very clearly the case in the region under discussion, its distribution

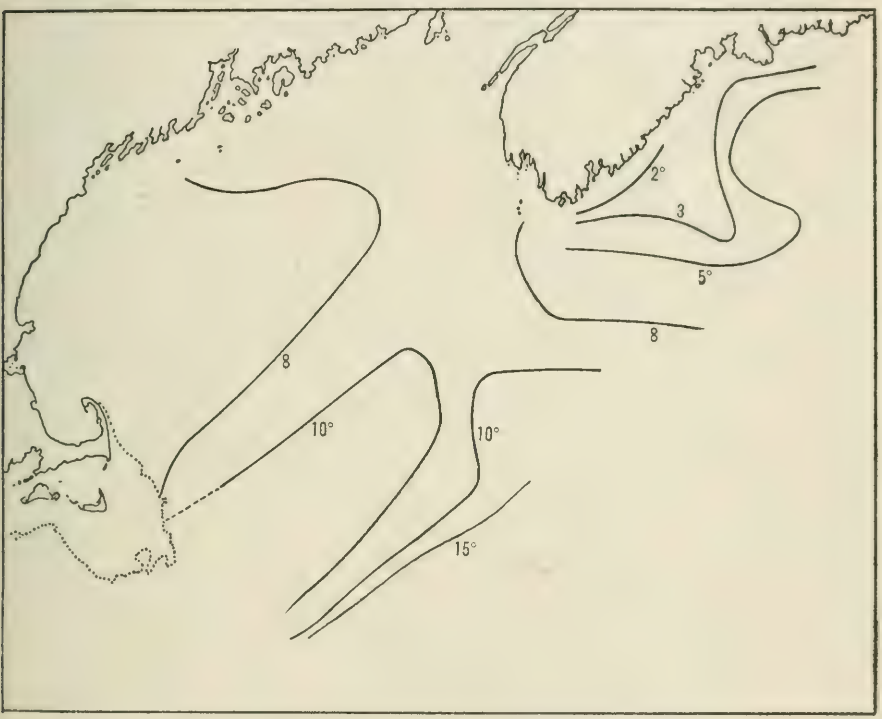

Fig. 15.— Temperature at 40 meters, July–August 1914.

(Fig. 18), suggesting, though it does not exactly reproduce that of temperature at 40 meters (Fig. 15). Thus there are two distinct areas of low salinity, one in the western side of the Gulf of Maine, the other off southern Nova Scotia, separated by salter water (32.‰+) in the eastern half of the Gulf. And the curve for 32‰ recalls that for 8° temperature in the extension of salter water (32.5‰+) from the east westward along the northern shore of the Gulf, as far as Penobscot Bay. But this salt water was not directly continuous with the even higher ocean salinities, being enclosed by slightly fresher water in the southeastern corner of the Gulf.

The lowest salinities of all (31‰−) like the lowest temperatures lay close to the southern coast of Nova Scotia, water fresher than 32‰ spreading seaward, fanlike off Shelburne, with an apparent tendency to swing around Cape Sable, contrasting with a salter tongue approaching the land off Halifax. Attention should also be drawn to the fact that surface salinities disclose an unmistakable fresh band, running diagonally across Georges Bank, corresponding to the low temperature there. And the sharp contrast in salinity between coastal and ocean water, illustrated by the sudden north-south rise in salinity along the southern edge of Georges Bank, also deserves mention.

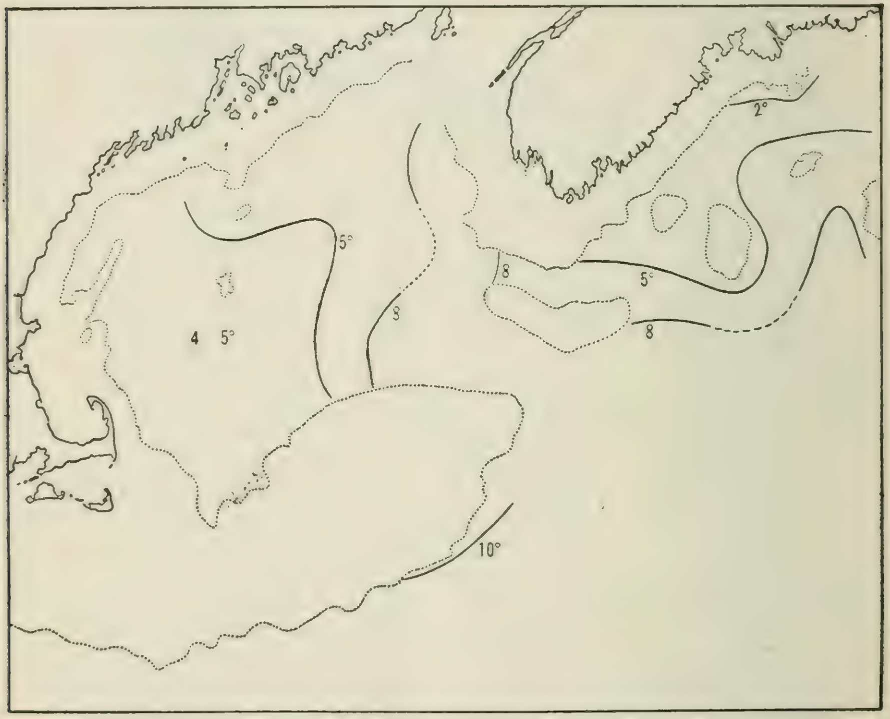

Fig. 16.— Temperature at 100 meters, July–August 1914.

Salinity Sections.— The water of the Gulf of Maine was freshest on the surface, saltest on the bottom (Fig. 19), the only exception to this rule being a slight decrease of salinity below 150 meters at one

Station (10249). Throughout the deeper parts of the Gulf the vertical range of salinity was considerable, the general type of vertical distribution, for its northern half, agreeing so closely with that of past years, that it is not necessary to reproduce the curves. And we again found the decrease in vertical range, passing northeast from Cape Ann, with which we are familiar (1914a, 1915).

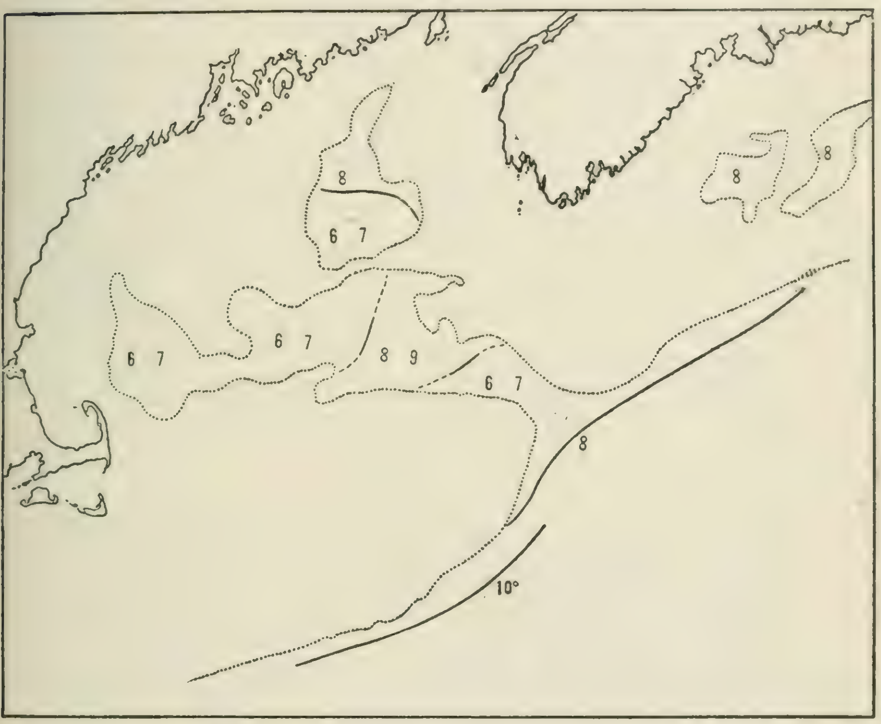

FIG. 17.— Temperature at 200 meters, July–August 1914.

In the southeastern corner of the Gulf (Station 10225), new ground for us, salinity increased very rapidly with increase of depth, to about 35‰ at 140 meters (Fig. 19), a higher reading than has ever been recorded before for any part of the Gulf; below that depth it was practically uniform down to the bottom, in 250 meters. And the salinity curve for the Eastern Channel (Station 10227) is of the same type.

On the Nova Scotia Banks, too, there was a very rapid vertical rise in salinity, from the surface downward (Fig. 22). And the stations in the basins on this part of the shelf (Fig. 23) differ from the shallower ones chiefly in continued vertical rise of salinity corresponding to the increased depth. But in the sink off Halifax, salinity was vertically uniform below 150 meters, which is the level to which the enclosing rim rises on the south. And this was probably also the case in the basin west of Sambro Bank (Station 10235).

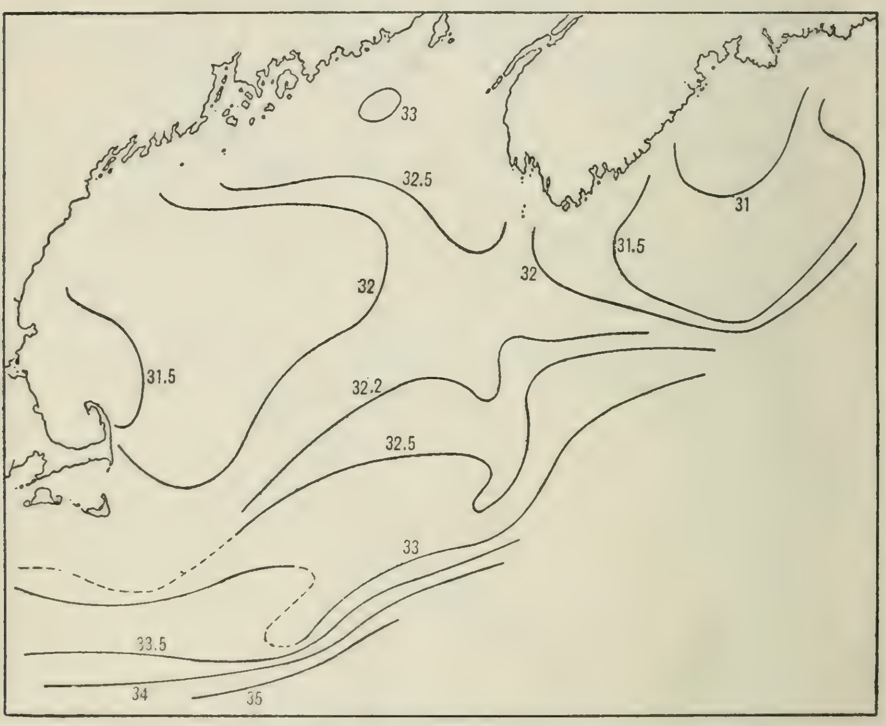

Fig. 18.— Surface salinity, July–August, 1914.

The salinity curves for the deep Stations (10218 and 10220) off Georges Bank and abreast of Marthas Vineyard (Station 10261, Fig. 24) are all of one type, freshest on the surface, with the maximum at 40–100 meters, below which the salinity decreases slowly, to about 34.9–35‰ at the lowest level (450–500 meters). Station 10218 was much

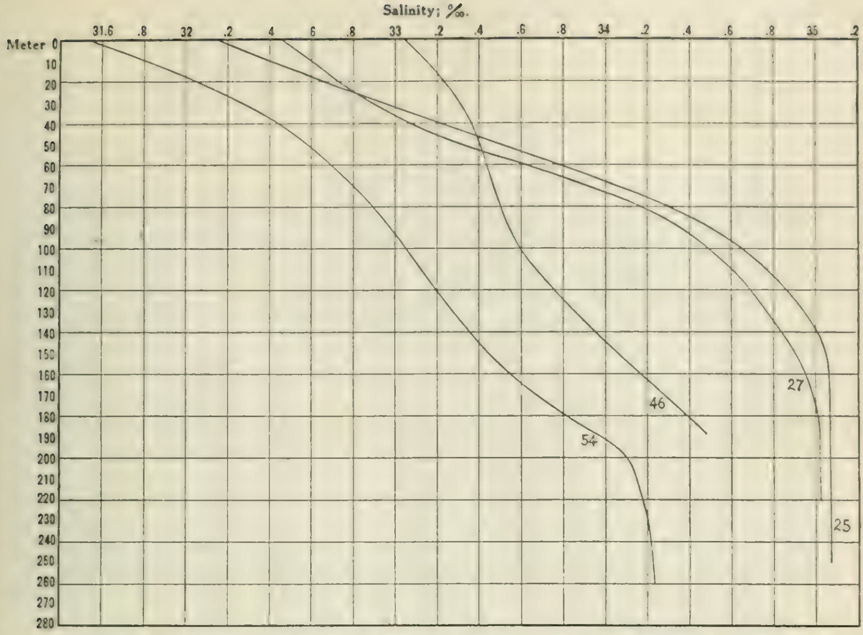

FIG. 19.— Salinity sections in the Western (Station 10254), and Eastern Basins of the Gulf of Maine (Station 10246): in its southeast corner (Station 10225) and in the Eastern Channel (Station 10227), July–August, 1914.

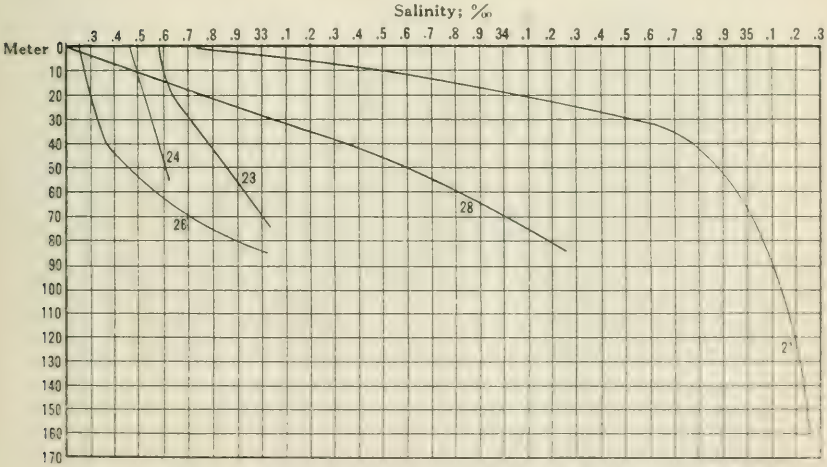

FIG. 20.— Salinity sections on the eastern part of Georges Bank (Stations 10221, 10223, 10224, 10226) and on Brown's Bank (Station 10228). July, 1914.

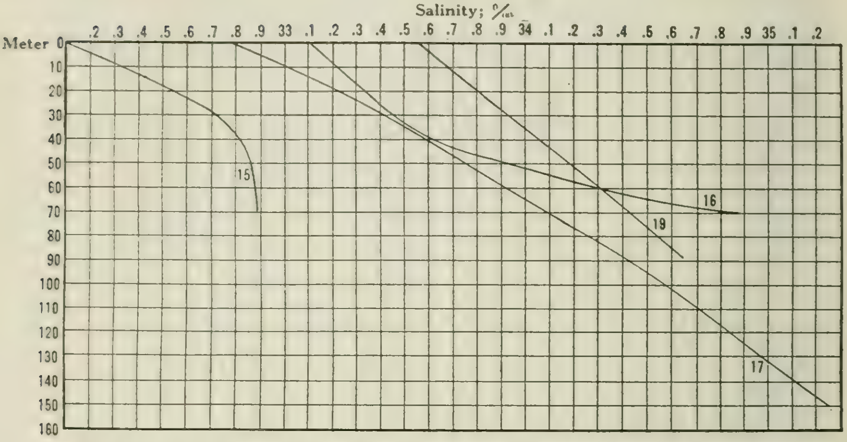

Fig. 21.— Salinity sections on the western part of Georges Bank (Stations 10215, 10216, 10217, 10219). July 1914.

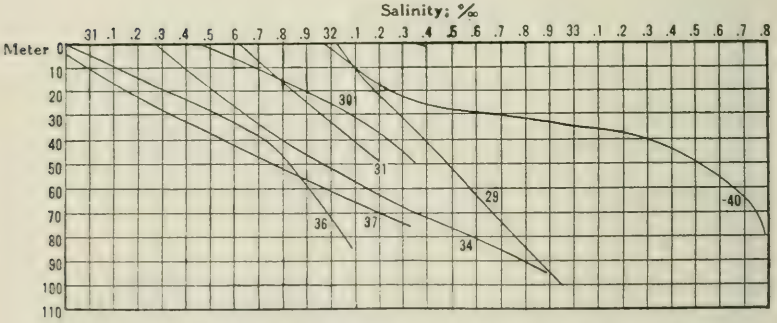

Fig. 22.— Salinity sections in the Northern Channel (Station 10229), and at the shallow stations off southern Nova Scotia (Stations 10230, 10231, 10234, 10236, 10237, 10240). July–August 1914.

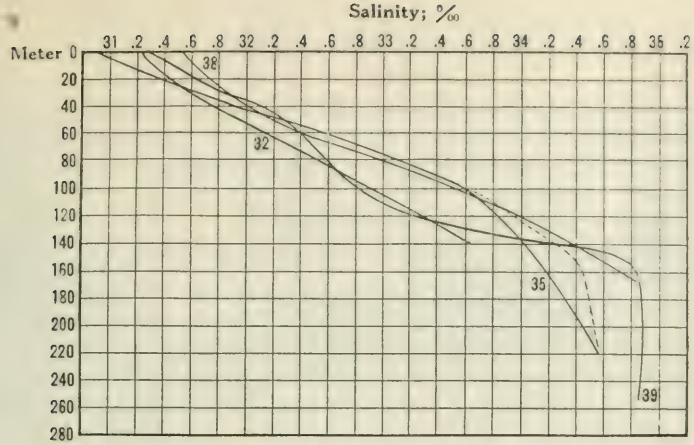

FIG. 23.— Salinity sections in the basins off southern Nova Scotia, (Stations 10232, 10235, 10238, 10239), July–August 1914.

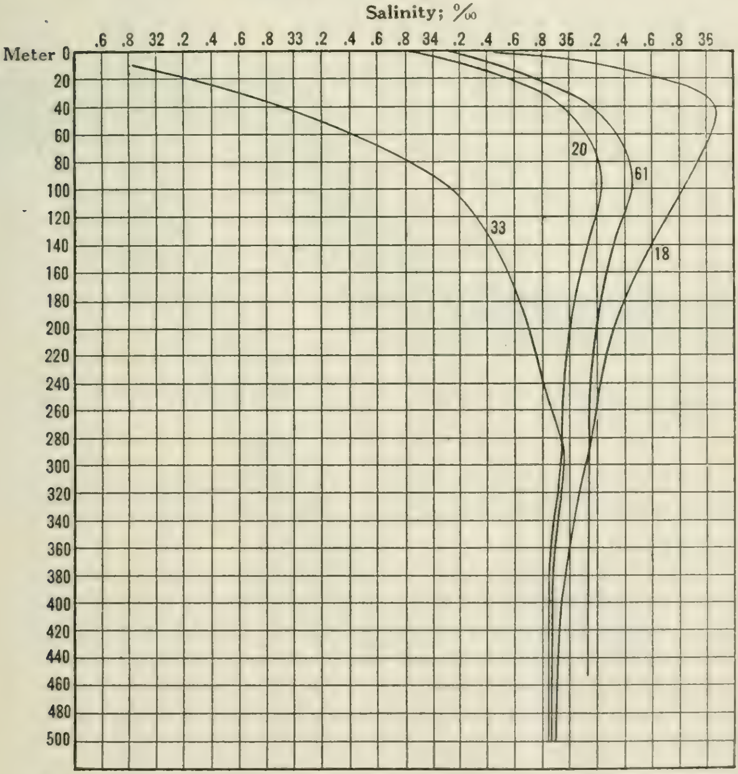

FIG. 24.— Salinity sections over the continental slope (Stations 10218, 10220, 10233, 10261), July and August 1914.

the saltest of the three, its salinity rising above 36‰ at 40–50 meters, Station 10220 the freshest. But while the maximum for Station 10261 was only about 35.4‰, it was slightly the saltest of the three below 300 meters.

The deep Station off Nova Scotia (10233, fig. 24) was much fresher on the surface, as fresh, indeed, as the water on the continental shelf; the salinity rising to the maximum of 34.96‰ at 300 meters: below which it decreased to 34.83‰ at 500 meters, *i. e.*, about the same as the water off Georges Bank at the same level.

The stations on the continental shelf south of Marthas Vineyard are still to be mentioned. Close to the land (Stations 10258 and 10263) the vertical salinity range was considerable, but very small (only about .1‰) over the 60 meter contour (Station 10259), and the curve for the latter was of an unusual type, saltest on the surface, freshest in mid-depths.

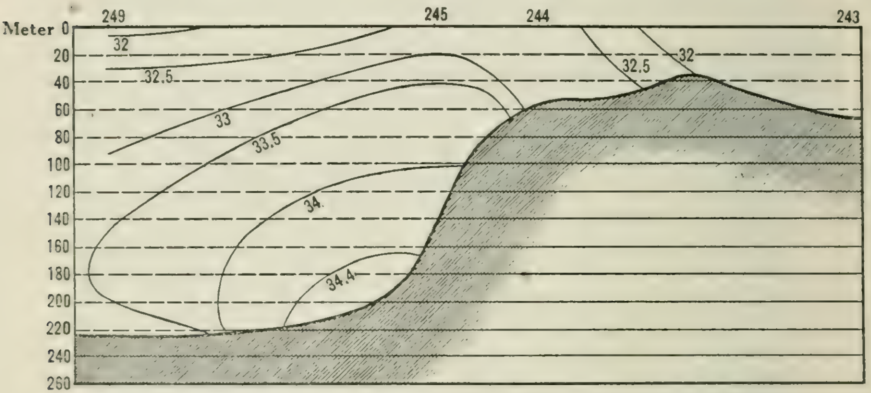

Fig. 25.— Salinity profile from the Eastern Basin of the Gulf of Maine (Station 10249) across German Bank (Station 10244) to the neighborhood of Cape Sable (Station 10243) August 11–13, 1914.

Salinity Profiles.— The high salinity of the eastern as compared with the western side of the Gulf, now known to be a characteristic feature in summer (1914a, 1915), is sufficiently illustrated by a profile running from the center of the Eastern Basin toward Cape Sable (Fig. 25). But though the influence of the still salter water of the Eastern Channel was evident in the high salinity at Station 10245, German Bank (Station 10244) was its eastern limit; east of which there was a sudden transition to much lower salinity in the Northern Channel and off Cape Sable (Stations 10229, 10230, p. 336).

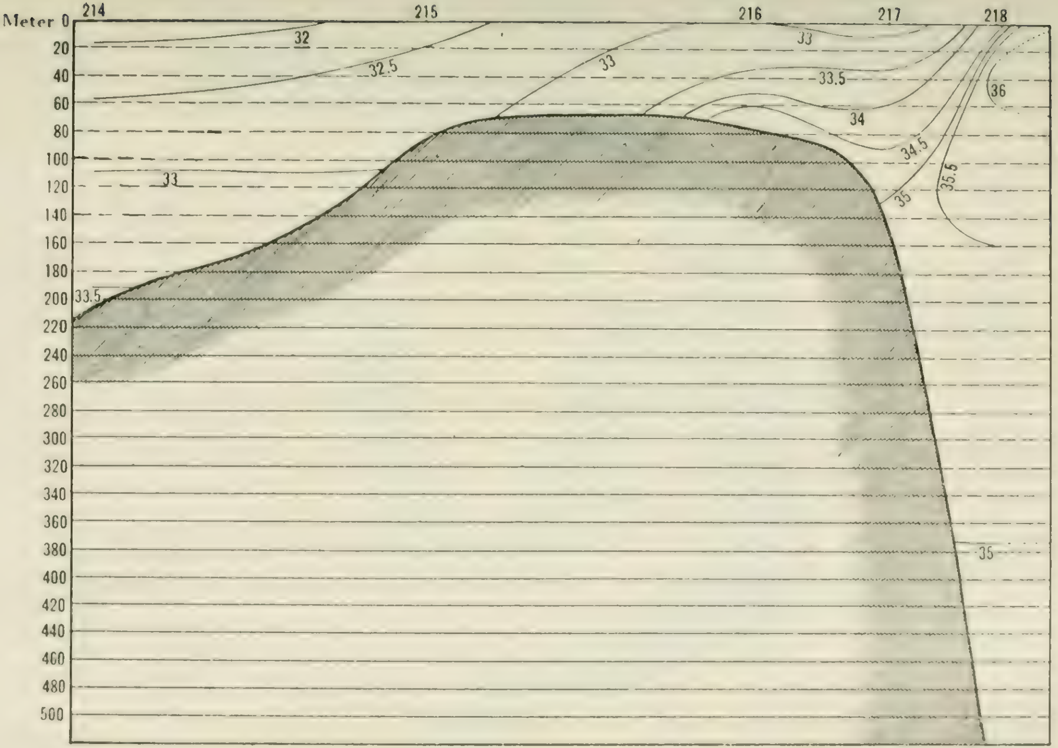

FIG. 26. Salinity profile crossing the western end of Georges Bank, from the basin of the Gulf of Maine on the north (Station 10214) to the continental slope on the south, July 19–21, 1914.

Salinities were much lower in the Western Basin of the Gulf of Maine than over the continental slope (Fig. 26); and the general increase of salinity, from north to south across the profile, above the level of Georges Bank, contrasted with the horizontal uniformity of salinity in this part of the Gulf below that depth, shows how effective a barrier the Bank is to any mixture of the two waters below it. At the eastern end of the Bank there is less contrast in salinity (Fig. 27), just as there is in temperature between Gulf water, and the water over the continental slope, and for a similar reason, Gulf water being considerably salter, especially near the bottom, water south of the Bank fresher, than further west. At the western end of the Bank the profile (Fig. 26) reaches practically undiluted Gulf Stream water, with salinities

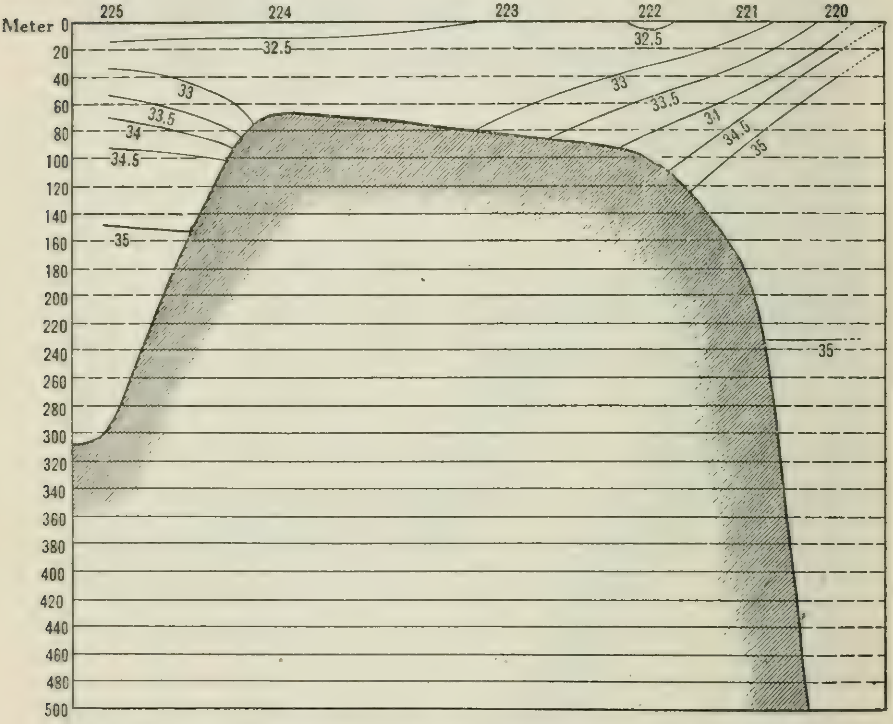

FIG. 27.— Salinity profile crossing the eastern end of Georges Bank from the Gulf of Maine (Station 10225) to the continental slope, July 22–23, 1914.

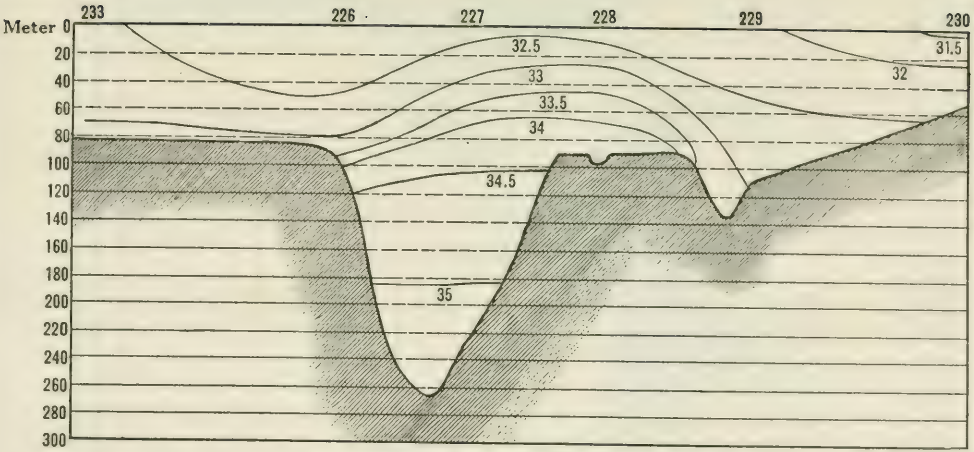

Fig. 28.— Salinity profile running from Georges Bank (Station 10223) across the Eastern Channel (Station 10227), Brown's Bank (Station 10228) and the Northern Channel (Station 10229) to the neighborhood of Cape Sable (Station 10230). July 23–25, 1914.

of upwards of 36‰; a fact worth noting, since this is the only time the GRAMPUS has encountered it on her recent cruises (1914a, 1915).

The salinity profile running from Georges Bank, across the Eastern Channel, toward Nova Scotia, shows that though the water was of about the same temperature over Brown's, as on Georges Bank, it was decidedly salter there (34‰). But its most interesting feature, and that of the succeeding profiles (Fig. 29–31), is that the low temperature of the Nova Scotian coast water (p. 174) is accompanied, in the upper layers, by correspondingly low salinity. Off Halifax (Fig. 31) the freshest water, like the lowest temperature, was localized close to the land, with a considerable increase in salinity, passing offshore.

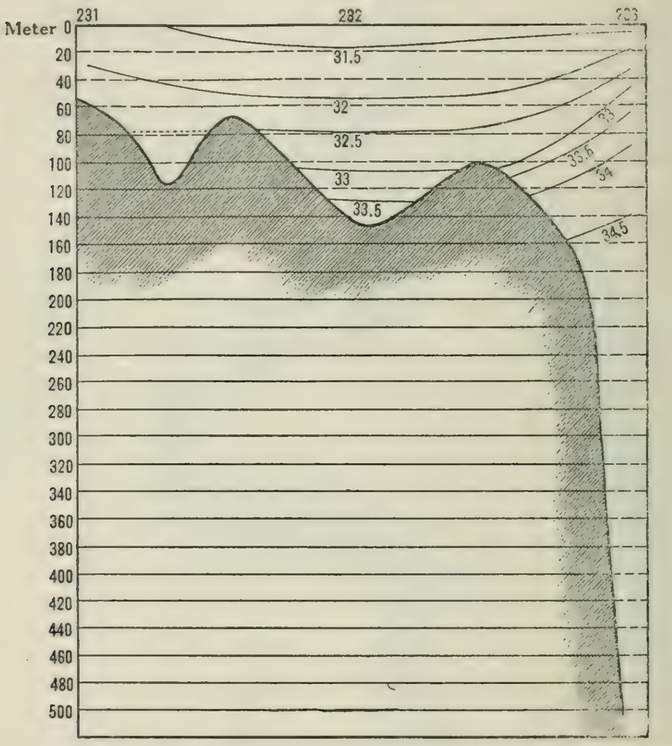

FIG. 29.— Salinity profile crossing the continental shelf off Shelburne, Nova Scotia (Stations 10231–10233), July 27–28, 1914.

But off Shelburne (Fig. 29) the upper layers, down to 40 meters or so, were uniformly fresher than 32‰ across the whole breadth of the shelf. And salinity, like temperature was lower over Le Have Bank (Fig. 30) than immediately north of it, a fact connected with the eddy-like circulation in this region (p. 182). Contrasting with the low salinity of the upper layers, that of the bottom waters of the basins off Shelburne and Halifax and on Emerald Bank (Fig. 30, 31) was very high, the latter being as salt as the water over the continental shelf off Shelburne (Fig. 29, 30). But, as pointed out, the latter was itself considerably fresher than the water at corresponding locations on the slope further west, its maximum salinity being only about 34.9‰,

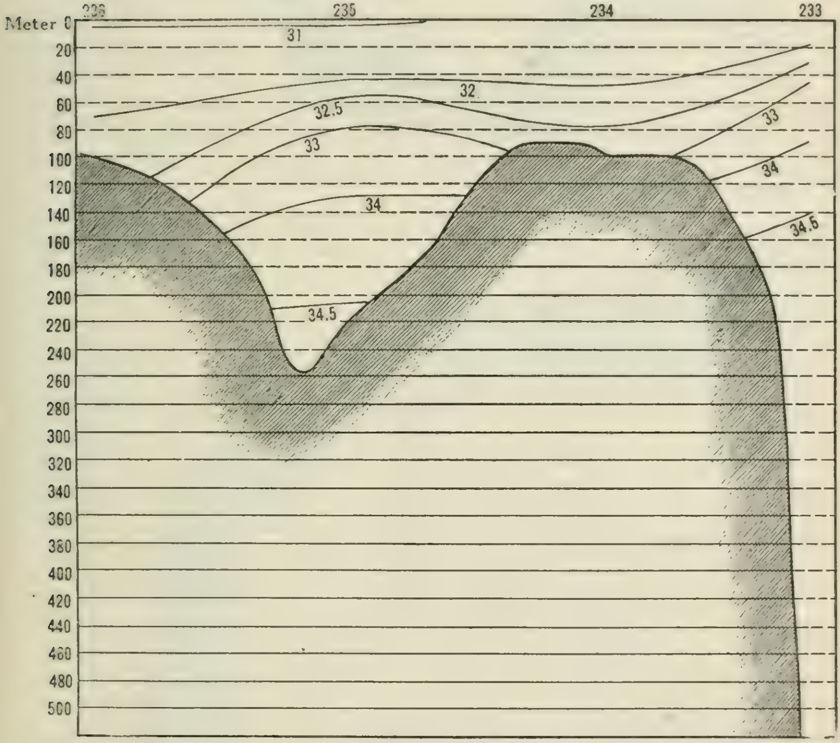

FIG. 30.— Salinity profile crossing the continental shelf obliquely off Halifax (Stations 10236–10233. July 27–August 2, 1914.

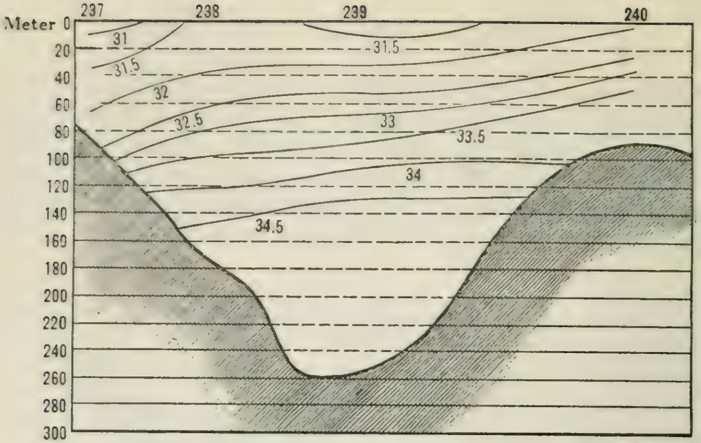

FIG. 31.— Salinity profile from Halifax (Station 10237) to Emerald Bank (Station 10240). August 6–7, 1914.

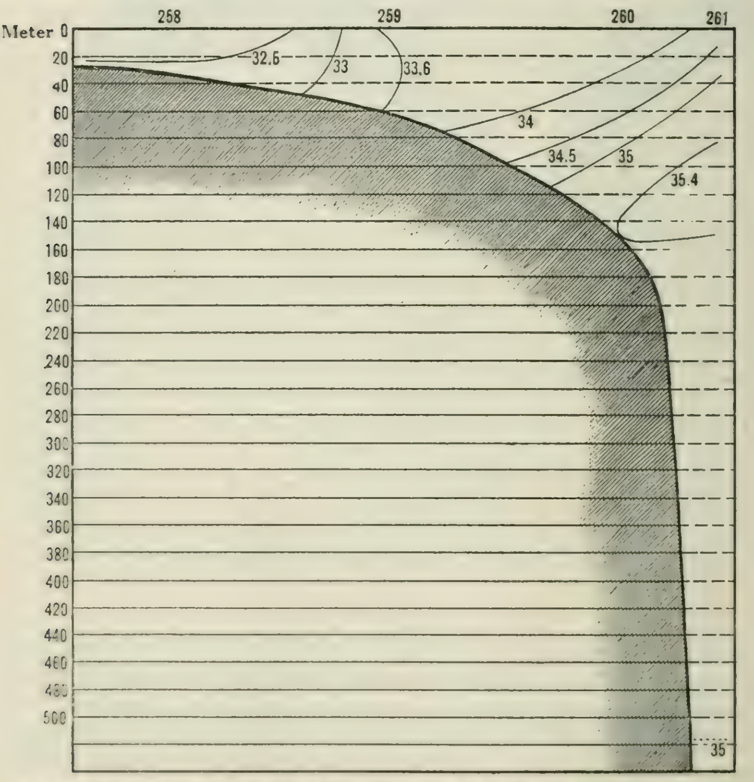

FIG. 32.— Salinity profile crossing the continental shelf off Marthas Vineyard, August 25–26, 1914.

a value actually below that of the bottom water of the southeastern part of the Gulf of Maine (p. 183).

Finally, the salinity profile from Marthas Vineyard to the continental shelf (Fig. 32) deserves brief mention. Along this line the general and characteristic increase in salinity from the land out across the shelf, reappears. And the peculiar conditions over the 60 meter contour (Station 10259), where the mid-depth was fresher than either surface or bottom, suggest that the fresh, cool land water was moving seaward at about the 40 meter-level, while the fact that there was little further rise in salinity in the upper 40 meters for a distance of 30 miles south of this point, is evidence of the mixing of land and ocean waters.

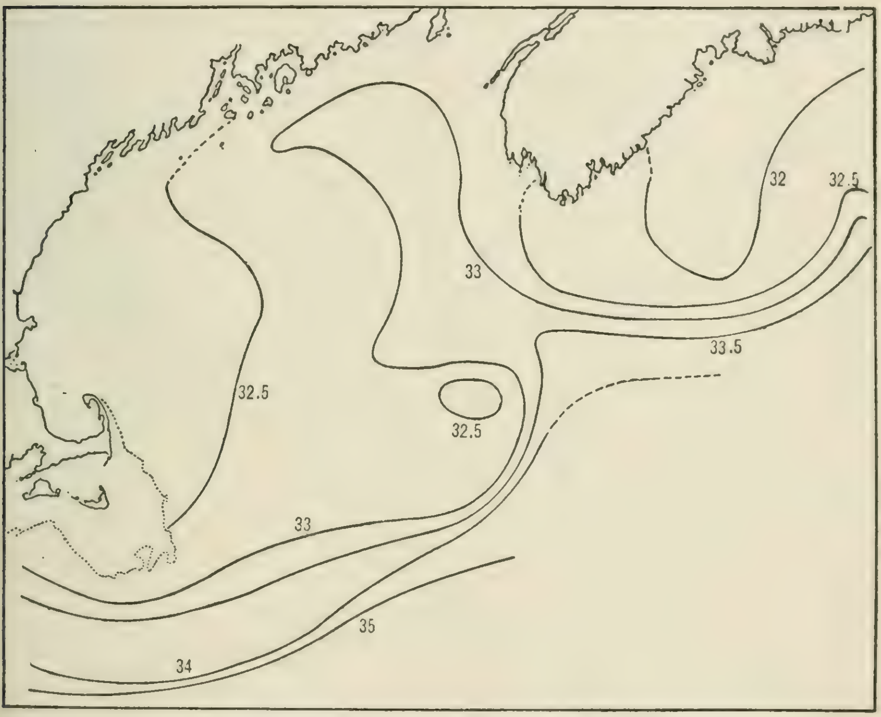

Fig. 33.— Salinity at 40 meters, July–August, 1914.

Salinity at the 40, 100, and 200 Meter-levels.— At 40 meters (Fig. 33), the fresh areas, in the western half of the Gulf of Maine and again off the southern part of Nova Scotia, are as evident as on the surface (p. 181, Fig. 18); as is the fact that the water is much salter (35‰+) over the continental slope than anywhere on the shelf. The ocean water in the eastern side of the Gulf appears as a tongue of 33‰+ extending northwestward from the Eastern Channel and Brown's Bank nearly to the coast of Maine, turning westward along the coast to Penobscot Bay, with a secondary intrusion into the southeastern corner of the Gulf, and even salter water (33.5‰) in the Eastern Channel. But the fresh tongue, so evident on the surface over nearly the whole length of Georges Bank (p. 182, Fig. 18), reappears only at the northeastern end of the Bank (Station 10226) at this level. And water salter than 33‰, which hardly encroaches at all on Georges Bank at its eastern end, covers almost half its breadth, at its western.

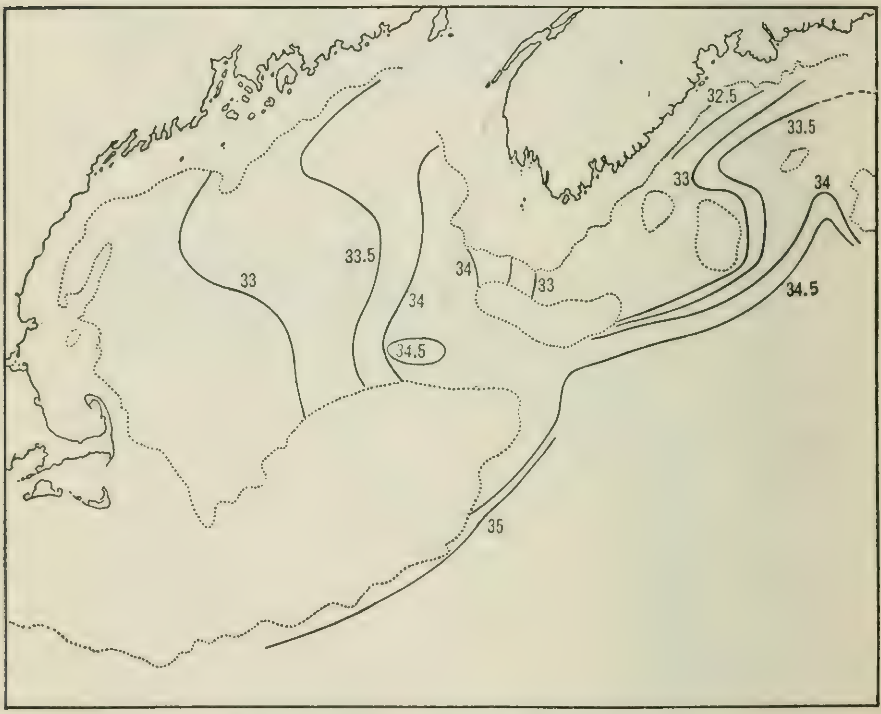

FIG. 34.— Salinity at 100 meters, July–August, 1914.

The salinity curves off southern Nova Scotia show the southward and westward expansion of comparatively fresh water off Shelburne, and the salter tongue approaching the land off Halifax as clearly at 40 meters as on the surface (Fig. 18).

There was no essential variation from this general distribution of salinity, *i. e.*, freshest in the western part of the Gulf of Maine and off southern Nova Scotia, saltest over the continental slope, down to 100 meters, except such as results from the enclosure of the basin of the Gulf by its southern rim (Fig. 34). And the influence of ocean water in the southeastern part of the Gulf, (34.‰), with its chief line of dispersal toward the northeastern corner, and thence westward along the coast of Maine, is as unmistakable on the 100 meter as on the 40 meter chart. The tongue of high salinity (33.5–34‰) off Halifax

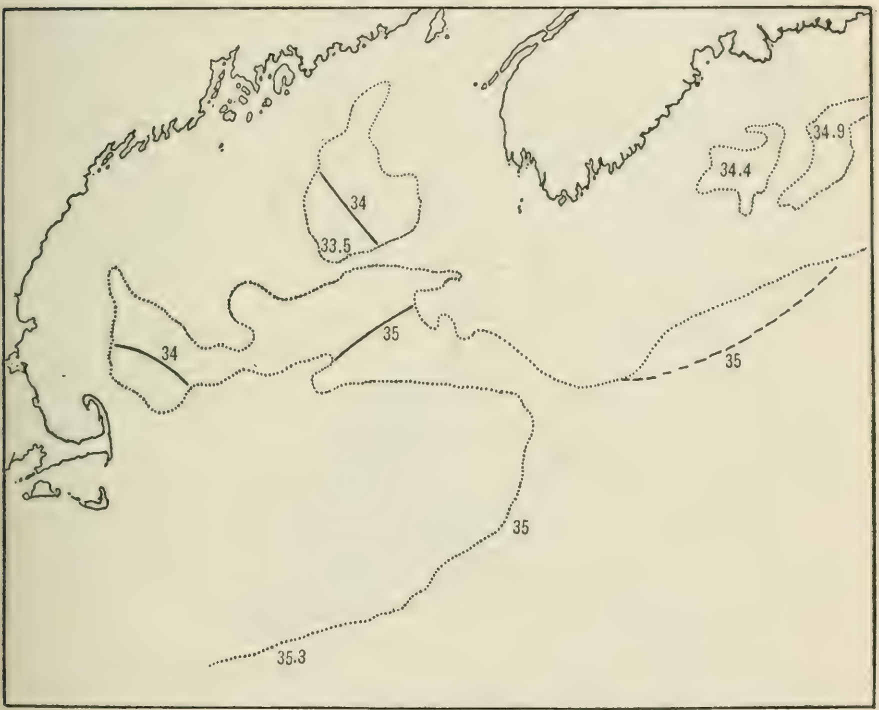

FIG. 35. Salinity at 200 meters, July–August, 1914.

is even more pronounced at 100 meters than at the shallower levels, besides approaching much nearer the land, to swing, eddy like, westward along the coast.

The sudden east-west rise in salinity in the Northern Channel between Brown's Bank and Cape Sable, the only direct connection between the coast water off southern Nova Scotia, and the Gulf of Maine at this level, is discussed below (p. 238).

At 200 meters (Fig. 35) the salinity was about 33‰–34‰ in the basin as a whole, rising to 35‰ in its southeastern corner and in the Eastern Channel; and to 35.3‰ off the southern face of Georges Bank. And the salinity was slightly higher (34.4–34.9‰) in the basins off southern Nova Scotia than in the inner parts of the Gulf.

Temperature and Salinity on the Bottom.— The Cruise of 1914 allows the salinity and temperature of the bottom water to be charted for the entire breadth of the continental shelf east of Cape Cod, for the first time. But even these charts (Fig. 36, 37) are, of course, for midsummer only: in the cold months hydrography would be different. However, they are of interest as showing the physical environment of the bottom fauna in that year and season.

The most interesting feature of the temperature chart (Fig. 36) is that the bottom waters, independent of depth, are coldest in the western part of the Gulf of Maine (3.6° in the trough west of Jeffrey's Ledge), and off southern Nova Scotia, these two cold areas being separated by considerably warmer water (7°–8°) in the eastern part of the Gulf of Maine, just as is the case in the mid-depths (p. 179). In the western part of the Gulf the coldest bottom water formed a band between the 75 and 100 meter contours; off Nova Scotia, the minimum, 1°–2°, lay between 20 and 50 meters, with much higher bottom temperatures (8°–9°) in the deeps off Halifax.

The bottom temperature was much higher (10°–12°) on Georges Bank as a whole, and on the outer part of the continental shelf off Marthas Vineyard than anywhere in the Gulf, at an equal depth, or on either German Bank (9°–10°), Brown's Bank (8°–9°) or Le Have Bank (2°–3°). And, judging from past years (1914a, 1915) Nantucket Shoals were probably likewise colder than Georges Bank on the bottom, while the curves show an indentation of 7°–8° water from the northeast on the eastern end of the latter (p. 179).

In the Gulf, bottom salinity (Fig. 37) corresponds much more closely with depth than does bottom temperature, the shoal coastal zone being, as a whole, the freshest, as exemplified by the zone of 32–33‰, which follows the coast all the way from Marthas Vineyard to Halifax, probably including Nantucket Shoals, as well as the northern half of Georges Bank. And Le Have Bank was also fresher than 33‰ on the bottom. On the other hand bottom water salter than 34‰ corresponds, though not precisely, to the deep basin of the Gulf, and includes the deep basins off Halifax (34.–34.9‰). But the bottom of the shallow Brown's Bank was almost equally salt (34.2‰), a phenomenon connected with the intrusion of water of high salinity via the Eastern Channel (p. 196), which also raises the bottom salinity of the southeastern corner of the Gulf above 35‰. The bottom water along a narrow belt following the continental slope between the 100 and 250 meter contours, was likewise salter than 35‰. Farther down the slope, however, the bottom salinity was lower, corresponding to the depth, and we found no bottom water as salt as 35‰ east of the Eastern Channel.

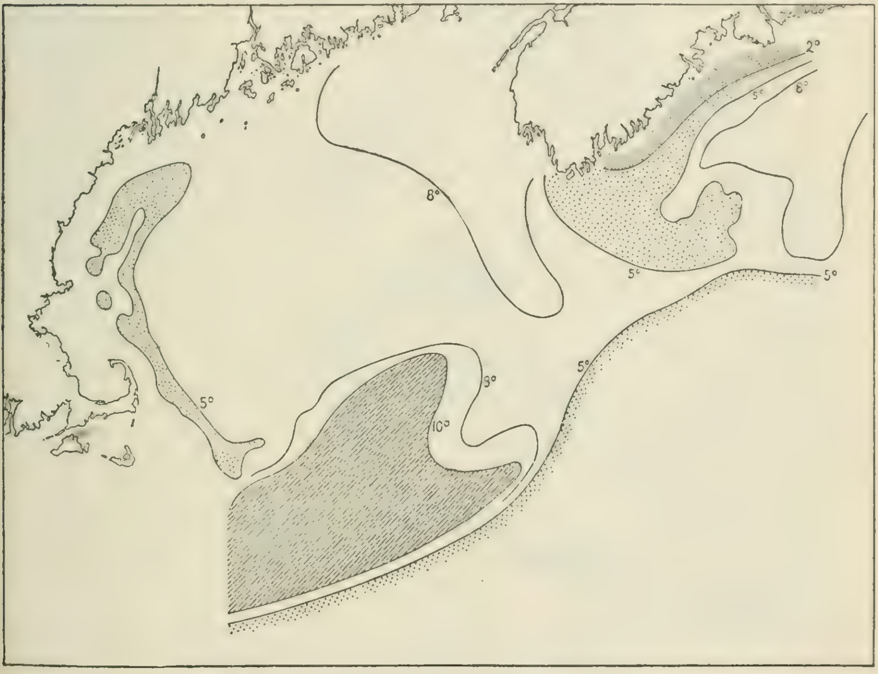

FIG. 36.— Temperature on the bottom, July–August, 1914.

⁞⁞⁞ = 2° –; ⁝ = 2° – 5°; ▨ = 10° +

Density, at the Temperature in Situ.— In a region where waters of different temperatures and salinities meet, where local vertical circulation is active, and where winter cooling and summer warming are pronounced, the distribution of density in the upper layers must not only be complex, but constantly changing at any given locality. And Gulf waters are no exception to this rule, if small differences be considered. But in its main outlines the density of the Gulf is comparatively uniform in summer. In 1914 and 1915, as in previous years (1914a, 1915), density, both on the surface and in the depths, was higher in the eastern than in the western part of the Gulf. But local differences were more pronounced in 1914, owing to the distribution of salinity (p. 231). And the area of low surface density (below 1.023), noted over the Western Basin in 1912 and 1913 (1914a, 1915) was much more extensive in 1914. In August, 1915, the surface density of the Western Basin (Station 10307; 1.0233) was lower than

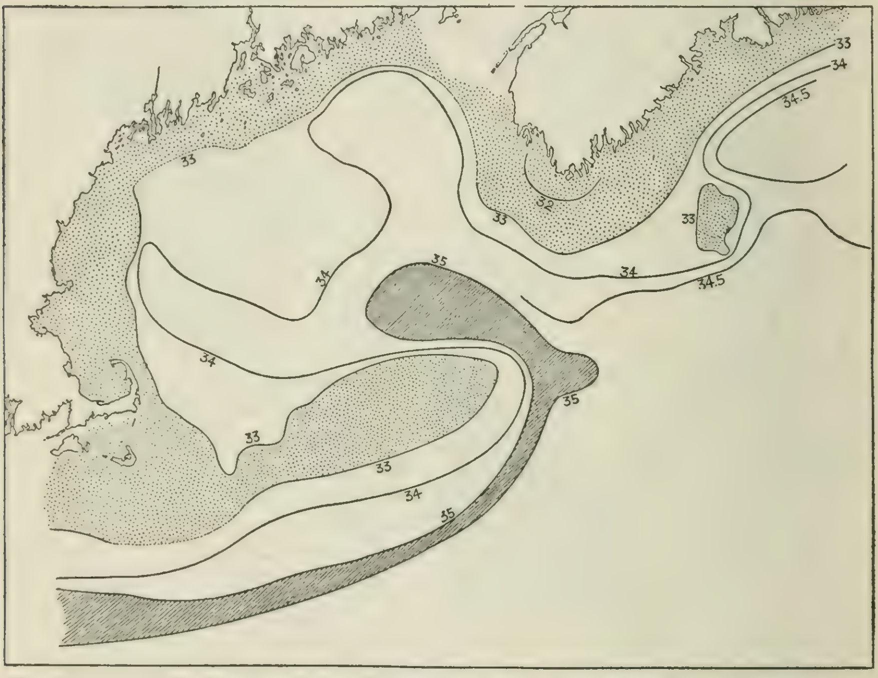

Fig. 37.— Salinity on the bottom, July–August, 1914.

⁙ = 33 ‰ −; ▨ = 35 ‰ +.

that of the waters east and north of it (Station 10318, surface density 1.0242); but the surface density off Cape Ann was even lower (Station 10306; density 1.0228).

It is now possible, for the first time to compare the density of the Gulf of Maine, and of the waters off southern Nova Scotia, with that over Georges Bank, in the inner edge of the Gulf Stream (Fig. 38), and in the mixed water along the continental slope. Down to 150 meters or so density was about the same in the western part of the Gulf as in the Gulf Stream water, except for the immediate surface of

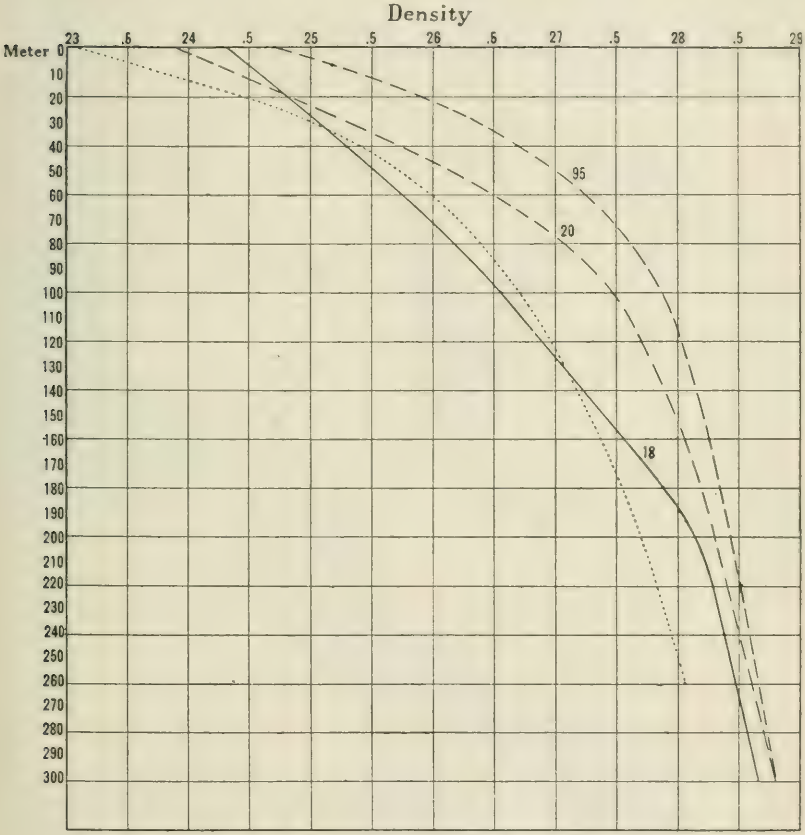

Fig. 38.— Summer density in the Western Basin of the Gulf of Maine. . . ., (average of 1914 and 1915); in the inner edge of the Gulf Stream ——— (Station 10218); and in the mixed water over the continental slope - - - - - - (Stations 10220, 10295).

the former, which was decidedly lighter, owing to solar warming, with no corresponding increase in salinity. And even this slight difference does not extend to the eastern part of the Gulf, surface density being nearly the same there as on Georges Bank, or at Station 10218. Thus, on the profile across the western end of Georges Bank, there was no great general difference in density, down to the level of the Bank, between the waters over it, and north and south of it, though below that level the latter were considerably the densest. But, and this is one of the most significant hydrographic discoveries made by the Grampus, the mixed water along the slope further east (Stations 10220, 10233, 10295), was considerably denser, from 50 down to about 180 meters, than the Gulf of Maine on the one hand, or Gulf Stream water on the other (Fig. 38), *i. e.*, at just the level where, owing to the topography of the bottom, ocean water can enter the Gulf only via the Eastern Channel. Below the latter the difference in density be-

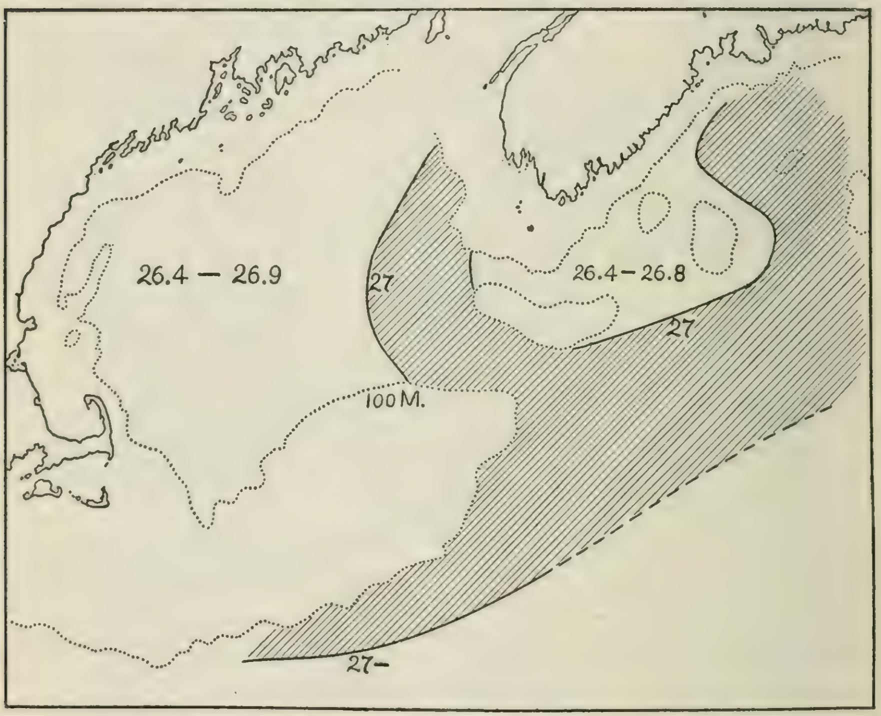

Fig. 39.— Density at 100 meters, July–August, 1915. Density above 1.027 is shaded.

tween Gulf Stream and mixed water diminishes, until at and below 200 meters, it is of doubtful validity.

The density at 100 meters, at which level the Gulf is practically an enclosed estuary (Fig. 39), is particularly instructive for its bearing on circulation (p. 239); for it not only shows this dense water (1.027+) separating the lighter Gulf Stream water from the slope in a triangle constantly widening from Station 10218 eastward, but reveals an equally dense tongue filling the Eastern Channel, and extending thence (Station 10225) northward into the Eastern Basin, while a second dense tongue (27+) approaches the land off Halifax, corresponding to the high salinity there (197). The intrusion of dense water into the Gulf via the Eastern Channel is equally evident down to about 200 meters; but below this level it is barred from the Eastern Basin by the ridge which encloses the latter on the south (Plate 2).

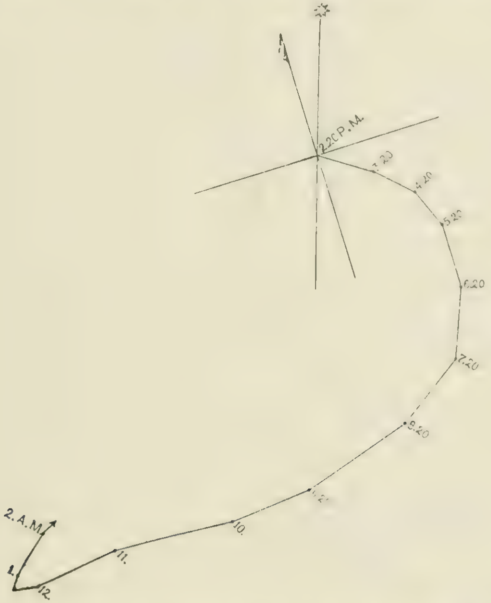

Fig. 40.— Diagram showing the surface current, at Station 10231, from 2.30 A. M. to 2 P. M. The distances between the dots give the drift. 1.5 cm. = 1 sea mile. The compass arrows are true and magnetic: variation about 19° W.

Current Measurements.— The Ekman current-meter was used at one Station (10231) in 1914, off Shelburne, where measurements were taken at a depth of 3 fathoms, hourly for twelve hours, to cover an entire tide, ebb and flood. Bottom (30 fathom) readings were taken hourly, for four hours, and then again after two hours, covering the ebb, and the first of the flood. The results of these two sets are given in full in the table, and the surface drift shown graphically in Figure 40. The movements of the surface water off Nova Scotia are greatly influenced by the wind (British Admiralty, 1903); hence the value of current measurements depends largely upon the weather. In the present instance, we were favored by a dead calm, preceded by two days of light variable winds; hence the current may probably be taken as normal for the time and place.

The current at three fathoms was southeasterly at first; then veered through south to southwest, which was its general course for the major part of the flood; then shifted suddenly to the northeast at the commencement of the ebb. During most of the set the velocity was considerable, rising to nearly one knot per hour during the last half of the flood. The general movement of water for the whole tide (Fig. 40) was about four miles toward the southwest.

The bottom current flowed toward the E N E during the ebb, veering to the southwest at the beginning of the flood. Its flow was much less rapid than the surface current, its maximum, at the strength of the ebb, only .34 knot. The records are not sufficiently complete to establish whether or not there was any dominant flow on the bottom. But the fact that the direction of flow was practically uniform during the ebb, and that it was exactly reversed at the commencement of the flood, suggests that the dominant movement, if any, was small.

Current at 3 fathoms. Station 10231–July 27–28. High tide, Halifax, 11.40 A. M. High tide, Shelburne, 12.26 P. M.

(Directions are compass bearings (magnetic) from which current flows).

July 27, P.M.

Time	2.30	3.20	4.20	5.20	6.20	7.15	8.10	9.20	10.00	11
Duration, seconds	300	300	300	300	300	300	300	300	300	300
Direction	WNW	NW	NW	N	N	NE	ENE	E by N	E	E by S
Vel. cm. per sec.	22.3	25.2	12.4	21.9	29.5	29.07	44.2	51.4	49.9	48.5
Vel. knot per hour	.43	.48	.24	.43	.57	.57	.85	.99	.97	.94

July 28, A.M.

Time	12.10	1	2
Duration, seconds	300	300	300
Direction	ENE	SW by S	WSW
Vel. cm. per sec.	30.9	6.2	28.6
Vel. knot per hour	.59	.12	.55

Current at 30 fathoms. Station 10231.

July 27, P.M.

Time	2.15	3.10	4	5	7	8
Duration, seconds	600	300	300	390	600	300
Direction	W by S	WSW	WSW	WSW	?	NE
Vel. cm. per sec.	12.8	17.6	11.2	5.8	8.1	10.9
Vel. knot per hour	.24	.34	.21	.11	.15	.21

A strong southwesterly surface drift was also noticed on July 29, when the current set the ship about 15 miles to the southwest, during the occupation of Station 10235 and the run thence to the coast, with a brisk east wind and rough sea.

No current measurements were taken in 1915. But both in May and in June of that year we encountered a very strong surface current on German Bank, in the former instance toward the west, in the latter toward the north and northwest, which cannot be explained by the tides; and though these could not be measured accurately, the May current had a velocity of at least one knot.

Seasonal Changes in Temperature and Salinity.

We already have a fairly complete knowledge of the regular seasonal changes which take place in the shallow waters off the western shore of the Gulf (1914a, 1914b, 1915). And the records for 1915 add a general view of the summer cycle for the Gulf as a whole, with much needed light on the seasonal fluctuations of the Cabot Current.

The seasonal variations may first be outlined for the more instructive and better known localities individually, a composite picture of the annual cycle of the Gulf as a whole being attempted below (p. 213).

The water off Cape Ann, (Fig. 41 [1]), as a whole, is coldest in February (1914b); solar warming is first evident in March, when the temperature of the surface rises to that of the deeps; and after that the surface water warms very rapidly, from about 3.5° to its maximum of 17°–18°, which is reached at the end of July or early in August. The surface then cools almost as rapidly as it warmed, its temperature falling to about 10° by the first of October, after which there is a slower, but constant cooling, to the February minimum. Summer warming is less evident and the maximum reached later and later, as the depth increases; at 50 meters the maximum is about 9°–10°, early in October; at 100 meters about 8° in November.

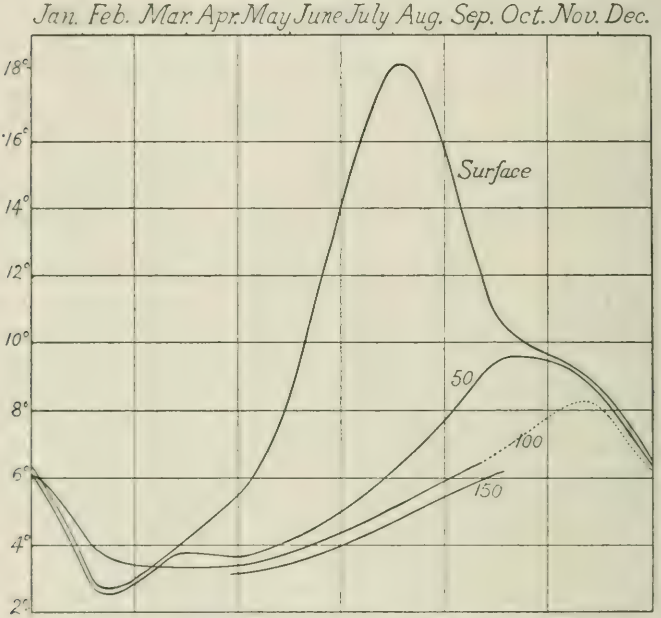

Fig. 41.— Annual range of temperature in the sink off Cape Ann at the surface, 50 meters, 100 meters, and 150 meters. (1912–1915). This is at the location of Station 10253 in 1914.

The salinity is highest at this locality in March (above 33‰ for the whole column), when spring freshening (1914b, p. 401) commences, the surface salinity diminishing until midsummer (July–August), with a change, in that period of about 2‰. The process is then reversed, the rise being equally rapid at first (August–October), then slower, but uninterrupted, until the maximum is once more attained. In the deep layers the maximum salinity is attained later (August–September); and the freshening is less and less pronounced as the depth increases, the annual range at 100 meters being only about .7‰. But the water is at its maximum salinity at about the same season, in all depths.

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[1] The diagrams for temperature and salinity off Cape Ann (Fig. 41, 42), are combined from the records of 1912–1915, but the annual variations are small.

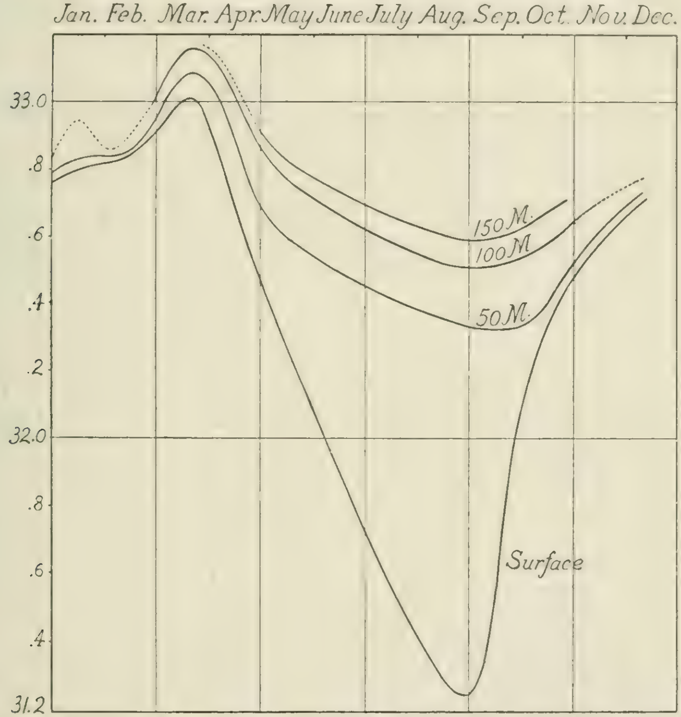

Fig. 42.— Annual range of salinity in the sink off Cape Ann, at location of Station 10253, at the surface, 50 meters, 100 meters and 150 meters, (1912–1915).

This region, the only one for which the records cover the entire year, typifies the temperature cycle of the upper layers of the western part of the Gulf as a whole. Thus both in the trough north of Cape Ann (Fig. 43), and over the Western Basin (Fig. 45, 46), the same rapid warming of the surface takes place during the spring and early summer, culminating in August; after which the water cools once more. And in the trough seasonal warming is appreciable down to 150 meters, just as it is off Cape Ann (Fig. 41). But in the deep Western Basin very little seasonal change took place with the advance of the season, in 1915, below 100 meters, which was the level of minimum temperature (p. 215). The temperature of the eastern half of the Gulf likewise rose, from May onward, as might have been expected. But the seasonal range of surface temperature is smaller there than in the west, (4°–20° in the western, 3°–13° in the Eastern Basin); and its maximum reached later in the season (Fig. 49, 51, 52). Thus summer warming results in a great increase in the vertical range of temperature, from spring to mid-summer, over the whole Gulf, except at localities, such as German Bank and the Grand Manan Channel, where the water is kept thoroughly mixed by strong tidal currents.

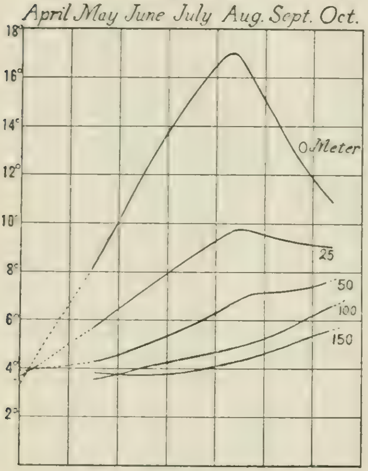

Fig. 43.

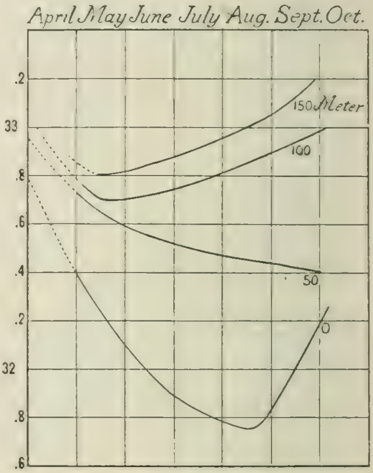

Fig. 44.

Fig. 43.— April to October temperatures at the surface, 25, 50, 100 and 150 meters, in the trough north of Cape Ann, for 1913–1915 (Stations 10278, 10325).
The dotted curves are for 1913 (1914b, p. 393).

Fig. 44.— April to October salinity at the surface, 50, 100 and 150 meters, in the trough north of Cape Ann for 1913–1915 (Stations 10278, 10325).
The dotted curves are for 1913 (1914b).

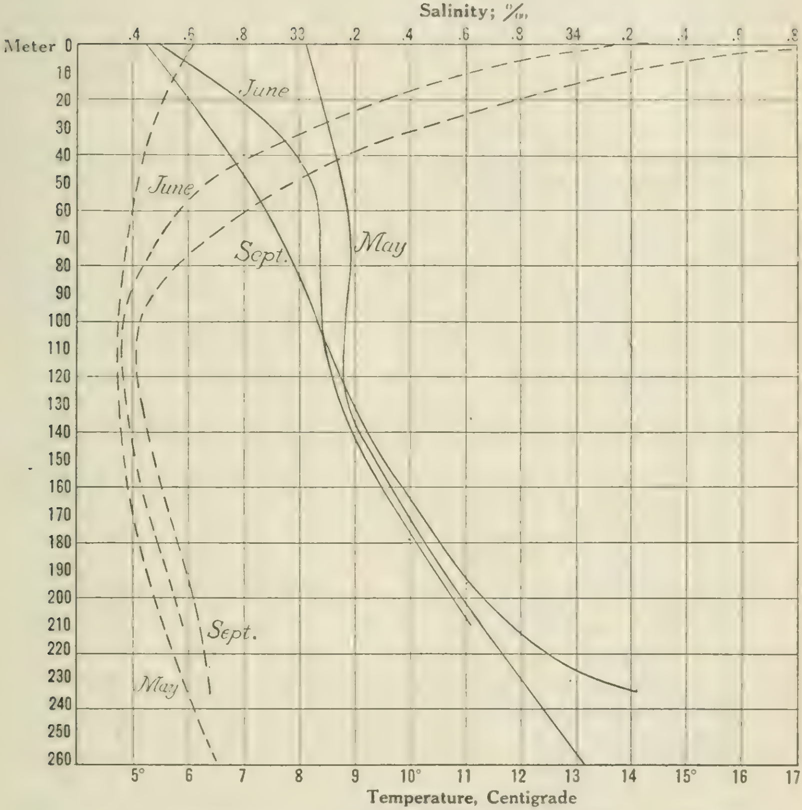

FIG. 45.— Temperature sections ......, and salinity sections ———, in the Western Basin of the Gulf of Maine, in May (Station 10267), June (Station 10299) and September (Station 10307, August 31) 1915.

But this vertical inequality is again obliterated during the autumn in the eastern, just as it is in the western part of the Gulf (1914b).

Even apart from such disturbing elements as vertical circulation caused by local currents, the seasonal range of salinity is less uniform over the Gulf than is that of temperature. To begin with, the seasonal variation is much smaller in the deep basin than near land, as might be expected in view of the influence of river water (p. 239; 1914a, 1915). Thus over the Western Basin the surface salinity changed only by about .7‰ (Fig. 45, 47) from May to September, as against a range of nearly 2.‰ off Cape Ann (Fig. 42); though the surface was at its minimum at about the same season. And there was practically no seasonal change in the mid-depths of the Western Basin; a statement likewise true of the bottom water from May to June. The latter, however, showed a decided rise in salinity from June to September. Similarly, the range of salinity in the Eastern Basin, in the

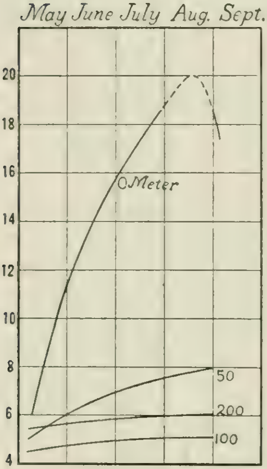

Fig. 46.

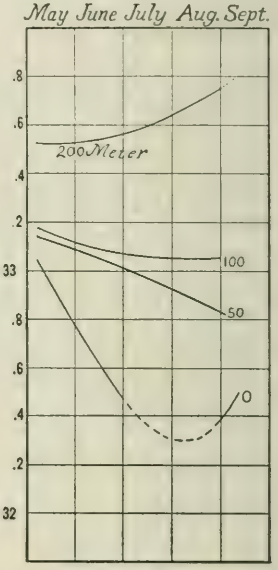

Fig. 47.

Fig. 46.— Temperature at the surface, 50, 100 and 200 meters, in the Western Basin, May–September, 1915.

Fig. 47.— Salinity at the surface, 50, 100 and 200 meters, in the Western Basin, May–September, 1915.

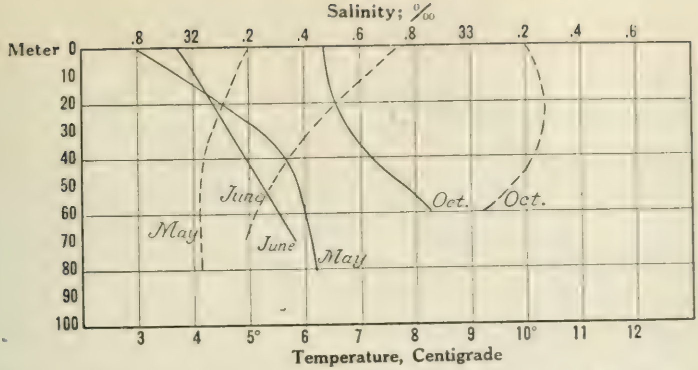

FIG. 48.— Temperature sections ...... and salinity sections ———, off Matinicus, in May (Station 10276), June (Station 10287 and October (Station 10329), 1915.

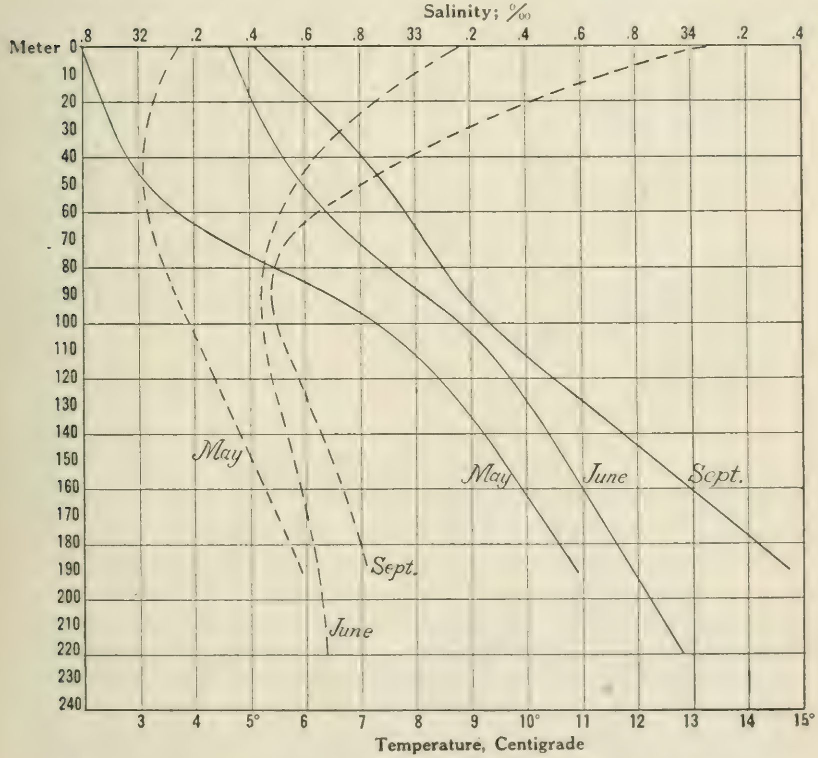

FIG. 49.— Temperature sections ,......, and salinity sections, ———, in the eastern part of the Eastern Basin of the Gulf of Maine, May (Station 10270), June (Stations 10288 and 10289), and September (Station 10310), 1915.

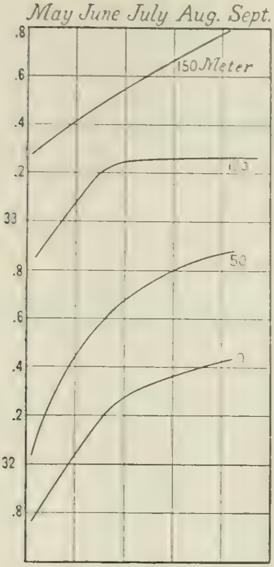

Fig. 50.

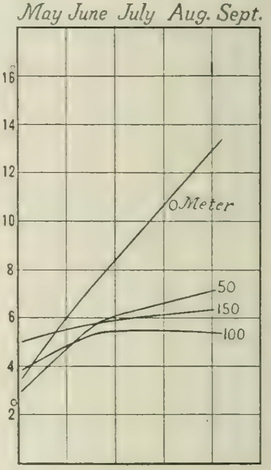

Fig. 51.

FIG. 50.— Salinity at the surface, 50, 100, and 150 meters in the eastern part of the Eastern Basin, May–September, 1915.

FIG. 51.— Temperature at the surface, 50, 100, and 150 meters in the eastern part of the Eastern Basin, May–September, 1915.

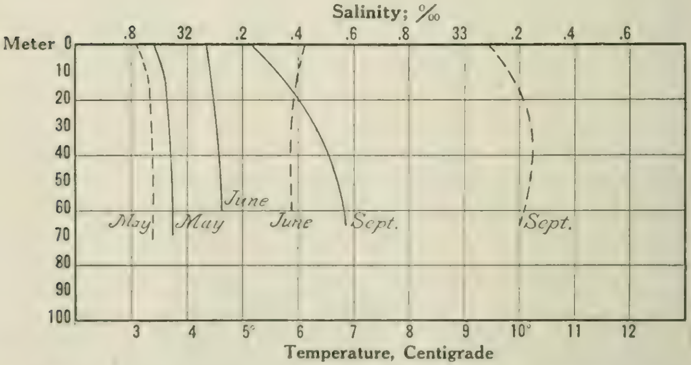

FIG. 52.— Temperature sections, ... , and salinity sections ———, on German Bank, May (Station 10271) June (Station 10290) and September (Station 10311), 1915.

seasons covered by our work, was only about .6‰ on the surface (Fig. 49, 50), though here the change was practically as great at all depths as on the surface.

Another local difference, which deserves special note, for its bearing on the cause of the annual spring and summer freshening, is that salinity reaches its minimum much earlier in the year in the eastern than in the western part of the Gulf. For example, while salinity is at its maximum, and the upper layers at their minimum, at about the same season (Fig. 44) in the trough north of Cape Ann as east of the latter, the deeper layers are at their minimum there in May instead of in midsummer. And further east, *i. e.*, off Matinicus (Fig. 48), next the coast east of Mount Desert, the eastern side of the Eastern Basin (Fig. 49, 50), German Bank (Fig. 52) and Lurcher Shoal (Stations 10272, 10315, p. 340), the entire column of water was freshest in May after which a rise in salinity took place at all depths.

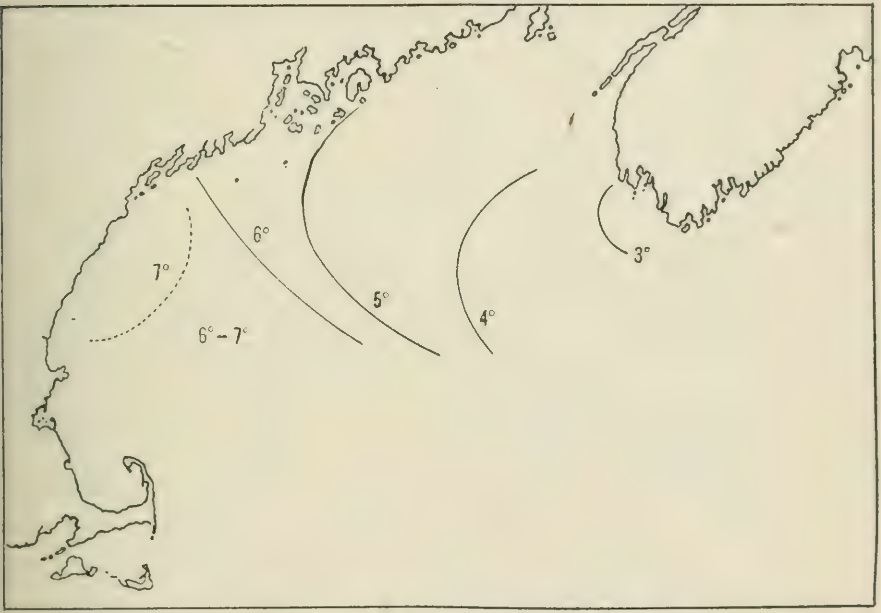

FIG. 53.— Surface temperature of the northern half of the Gulf of Maine, May, 1915.

The general hydrographic changes which characterize the Gulf as a whole as exemplified by the observations in 1915, are illustrated by the charts and profiles (Fig. 53–71).

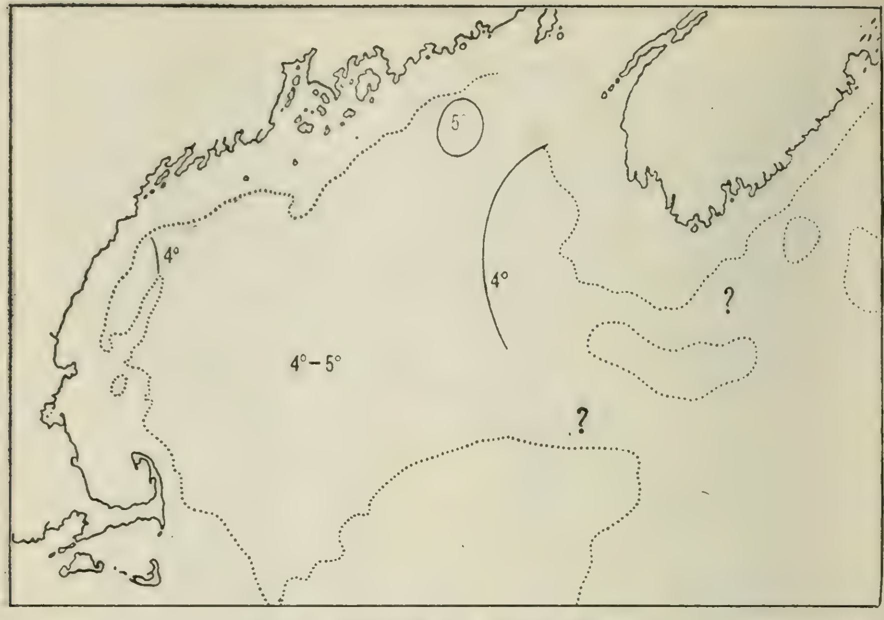

Fig. 54.— Temperature at 100 meters, May, 1915.

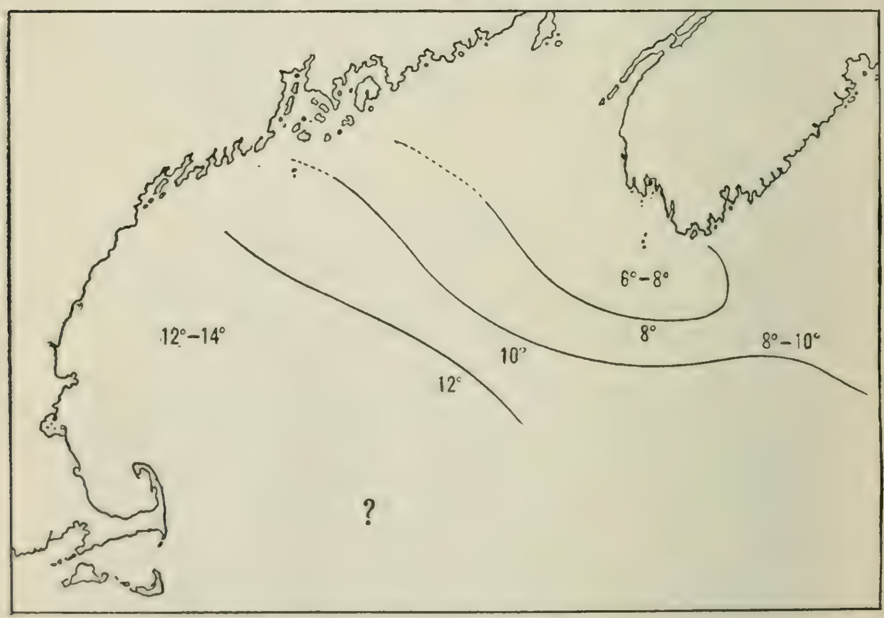
6°–8°
12°–14°
8°
8°–10°
10°
12°
?

Fig. 55.— Surface temperature, June, 1915.

In early May the temperature of the upper 15 meters or so was already considerably higher than the winter minimum, much more so in the western than in the eastern side of the Gulf, with a west to east range on the surface (Fig. 53) from about 7° off Cape Ann to 3° on German Bank. But in the mid-depths, at from 40 to 100 meters, the coastal zone on the western side of the Gulf (Stations 10266, 10278), was practically as cold (3°–4°) as German Bank and its western slope (Fig. 54, 69), with warmer water in the intervening basin. The profile (Fig. 69) is also interesting both as showing that the minimum temperature for the central part of the Gulf was at about 100 meters, with warmer water below, the thick layer of surface water warmer than 5° over the Western Basin foreshadowing the high temperature which characterizes that region in summer (p. 166), and as illustrating the mass of cool surface water (4°–) in the eastern side of the Gulf which finds its counterpart in low salinity (p. 223). With the advance of the season the temperature of the surface layers continues to rise faster in the western than in the eastern half of the Gulf, until by the

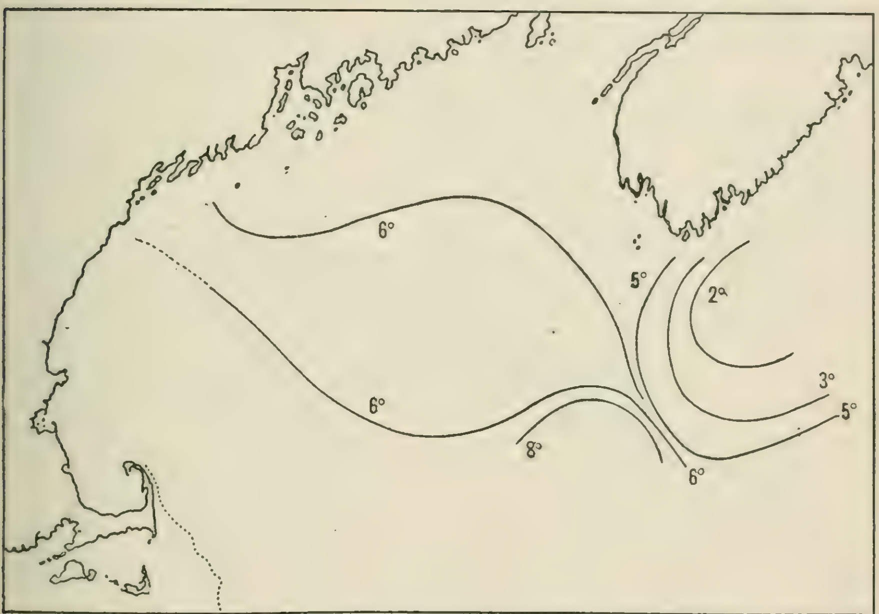

Fig. 56.— Temperature at 40 meters, June, 1915.

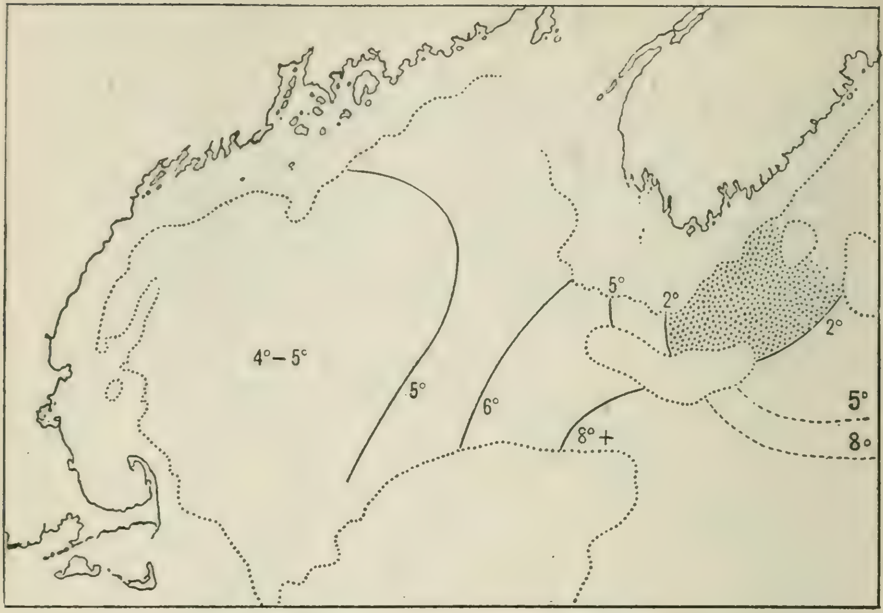
4°– 5°
5°
6°
8° +
5°
2°
2°
5°
8°

Fig. 57.— Temperature at 100 meters, June, 1915.

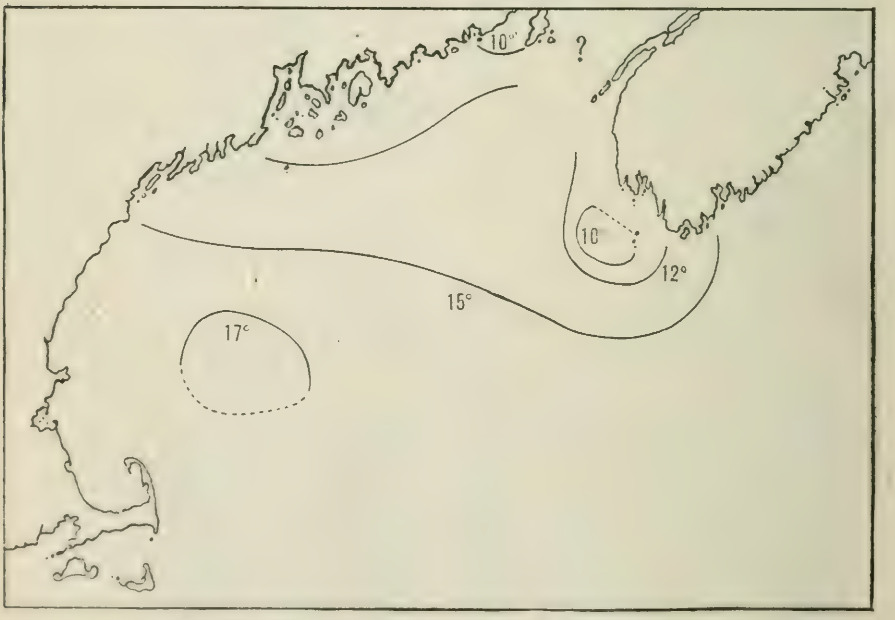
10°
?
10°
12°
15°
17°

Fig. 58.— Surface temperatures, August 31–September 7, 1915.

middle of June the discrepancy between the surface readings on the two sides was upward of 6° (12°–14° in the Western Basin, 6°–8° on German Bank, and along the west coast of Nova Scotia, Fig. 55). But in the mid-depths, the western side of the Gulf lags behind its central and southeastern parts in summer warming (Fig. 56, 57), which results in the reestablishment of one of the most important features of summer, *i. e.* the fact that the eastern part of the Gulf is warmer than the western, except for the immediate surface.

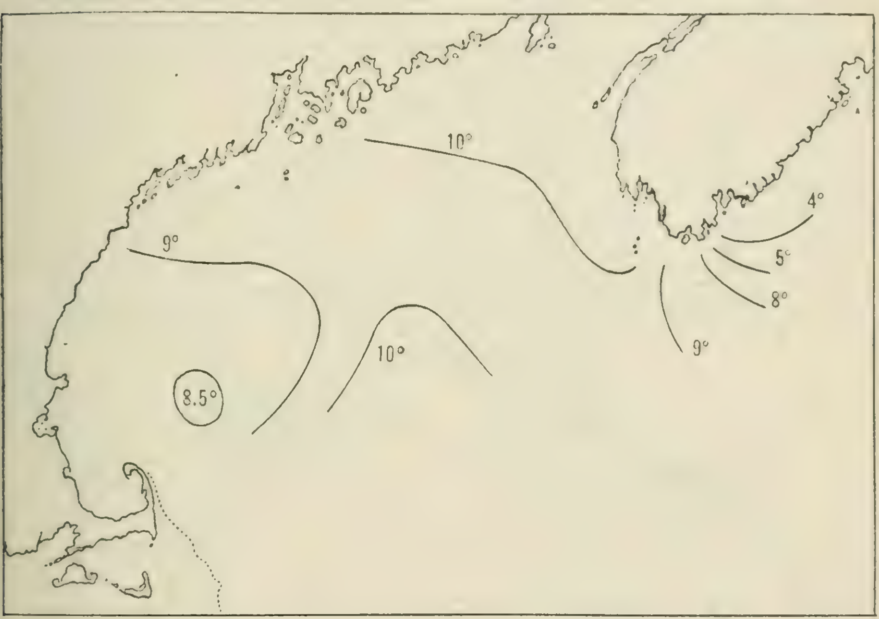

FIG. 59.— 40 meter temperature, August 31–September 7, 1915.

The deeper levels are particularly interesting at this season, because our work extended far enough east to reach the undiluted Cabot Current, which was not the case in May. At 40 meters the influence of the current was evident (Fig. 56) across the whole of the continental shelf abreast of Shelburne in very low temperature (.7°–2.87°), and in the shelf-like projection of water colder than 5° beyond the slope, at the 70–80 meter-level, with higher temperatures below, as well as above it (Fig. 73) the same as in summer (p. 174). And the tem-

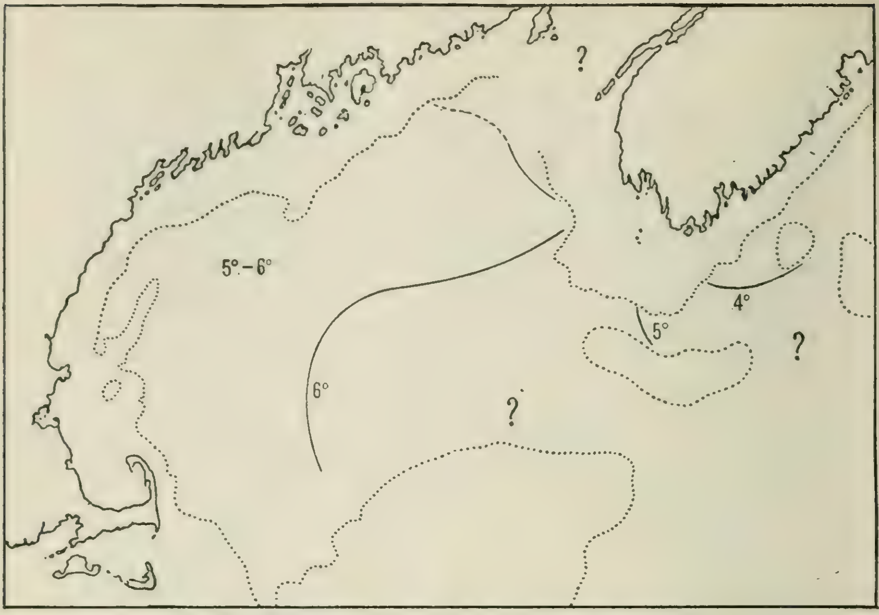

FIG. 60.— 100 meter temperature, August 31–September 7, 1915.

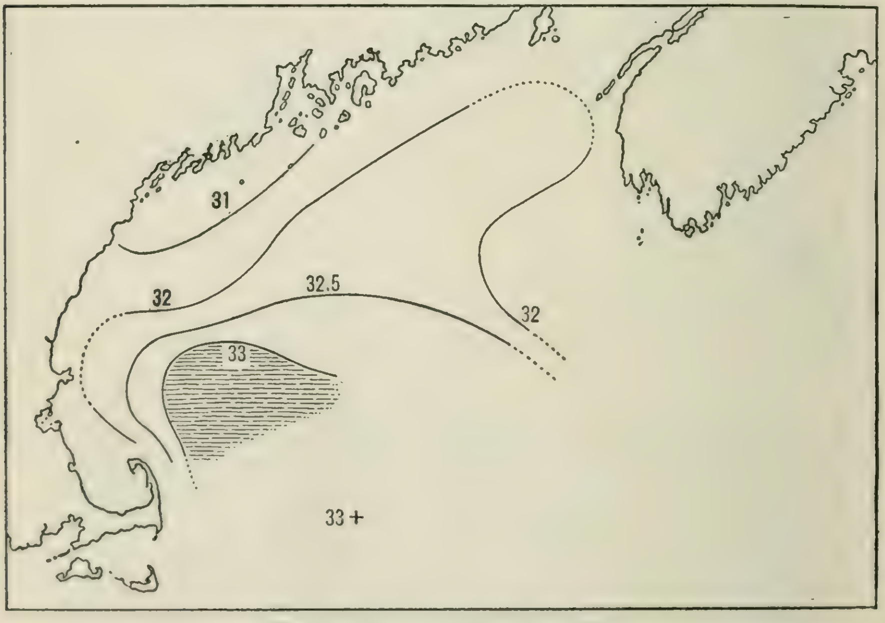
31
32
32.5
32
33
33 +

FIG. 61.— Surface salinity in May, 1915.

perature as a whole was lower along this line as well as over the slope, in June than in the preceding August, as might have been expected; while had it not been for solar warming of the previous few weeks, the surface would doubtless have been nearly as cold as the 60 meter-level, as is probably the case in winter. But in June this cold Cabot Current water has no apparent effect on the temperature of the Gulf at any depth, there being a sudden transition in the Northern Channel and over Brown's Bank from the low temperatures (2.°) of the one to warmer water of the other (Fig. 56, 57).

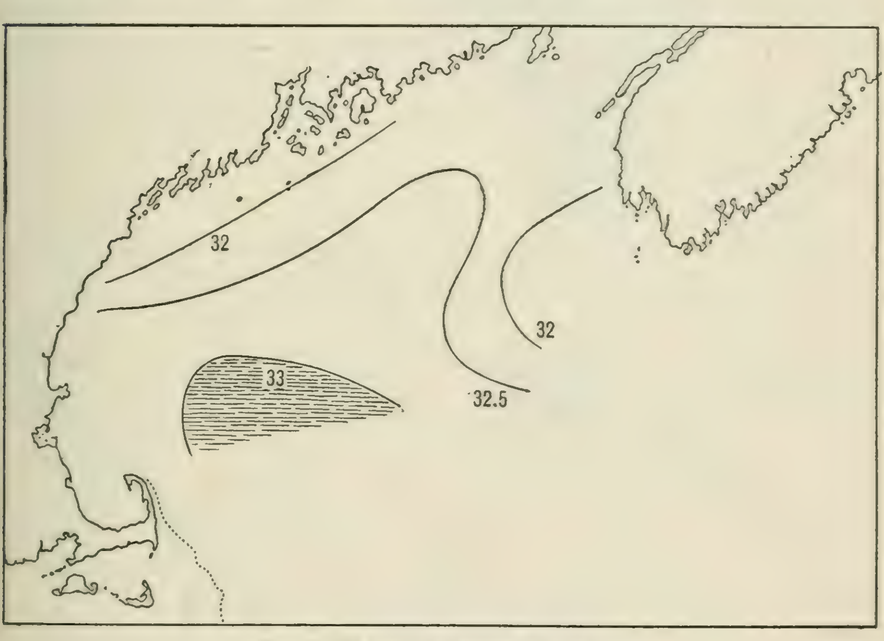

Fig. 62.— Salinity at 40 meters, May, 1915.

Judging from the experiences in past years, the temperature of the upper layers had probably passed its midsummer maximum and autumn cooling had commenced by late August, and early September, when we made our third oceanographic cruise in 1915, as is illustrated by comparing the surface temperatures for July and August, 1914 (Fig. 1) with the chart for September 1915 (Fig. 58). But while the western part of the Gulf had cooled by about 2°, cooling had not penetrated downward to any distance, for the 40 meter-level (Fig. 59)

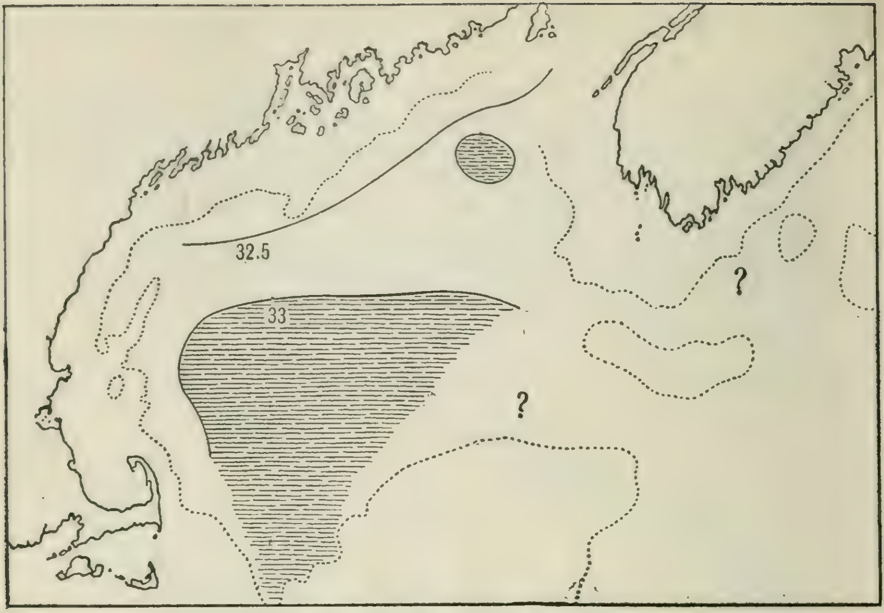

Fig. 63.— Salinity at 100 meters, May, 1915.

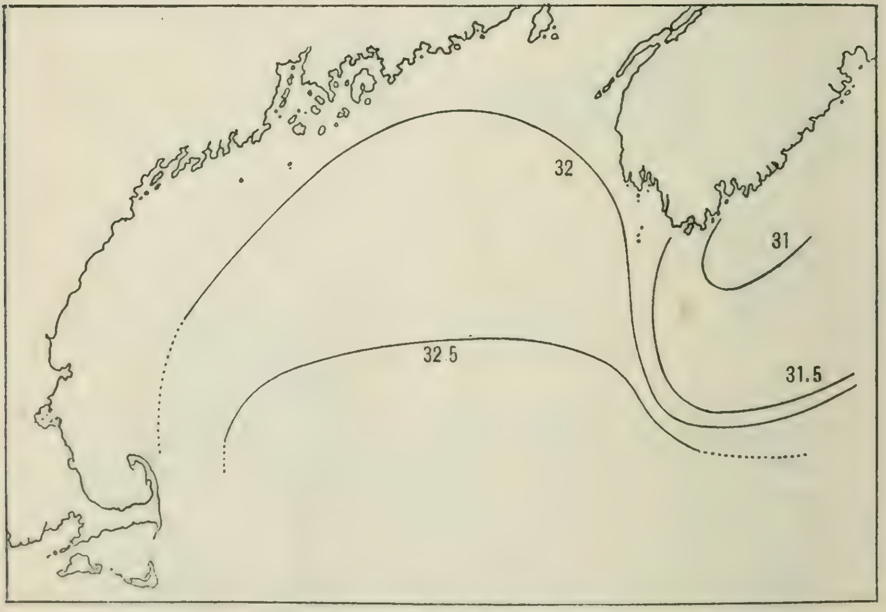
32
31
32.5
31.5

Fig. 64.— Surface salinity, June, 1915.

was slightly warmer in September, 1915, than in August, 1914, though the general distribution of temperature was the same. And this is also true at 100 meters (Fig. 60) where the western half of the Gulf was about 1°, the waters off western Nova Scotia 2°–3° warmer in September than in June. And the temperature profile across the Gulf for September (Fig. 71) corresponds fairly well with the corresponding profile for August, 1913 (1915, Fig. 71), especially in the presence of the cold layer at about 100 meters, while the banking up of bottom water warmer than 8° against Nova Scotia reproduces conditions obtaining in 1913 (1915).

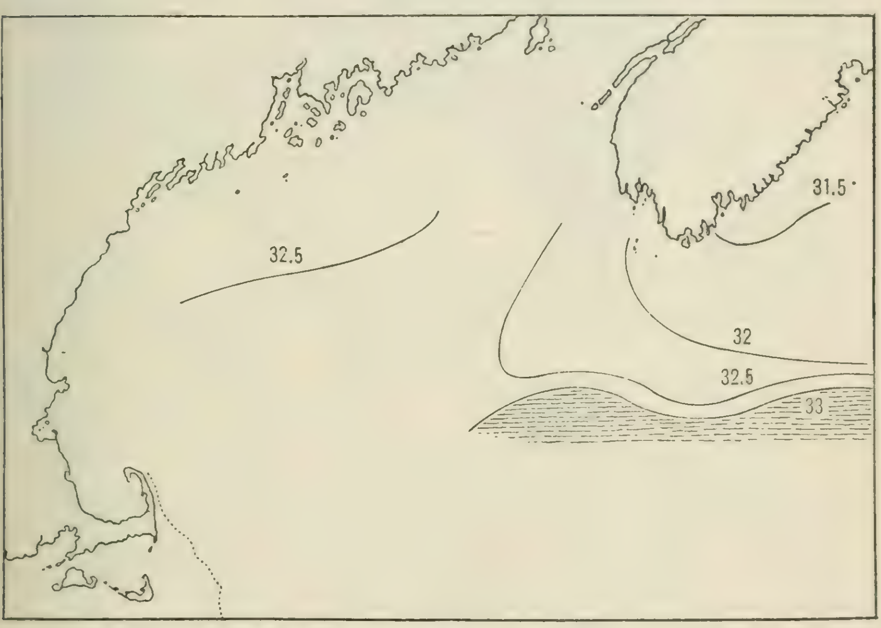

FIG. 65.— Salinity at 40 meters, June, 1915.

In the depths of the Gulf, at and below 200 meters, there was practically no change in temperature from May to September, except off the slope of German Bank (Stations 10270, 10310) where it rose by about 1°.

The September temperatures off Shelburne (Fig. 76) are interesting, in connection with salinity, as evidence of a shrinkage of the Cabot Current (p. 242), the minimum temperature having risen from .7° to

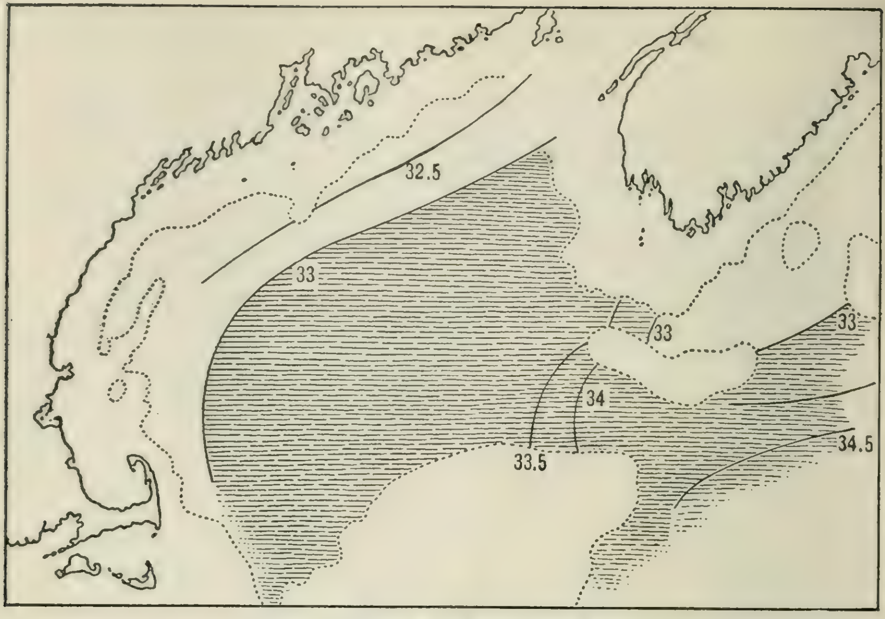
32.5
33
33
33
34
33.5
34.5

FIG. 66.— Salinity at 100 meters, June, 1915.

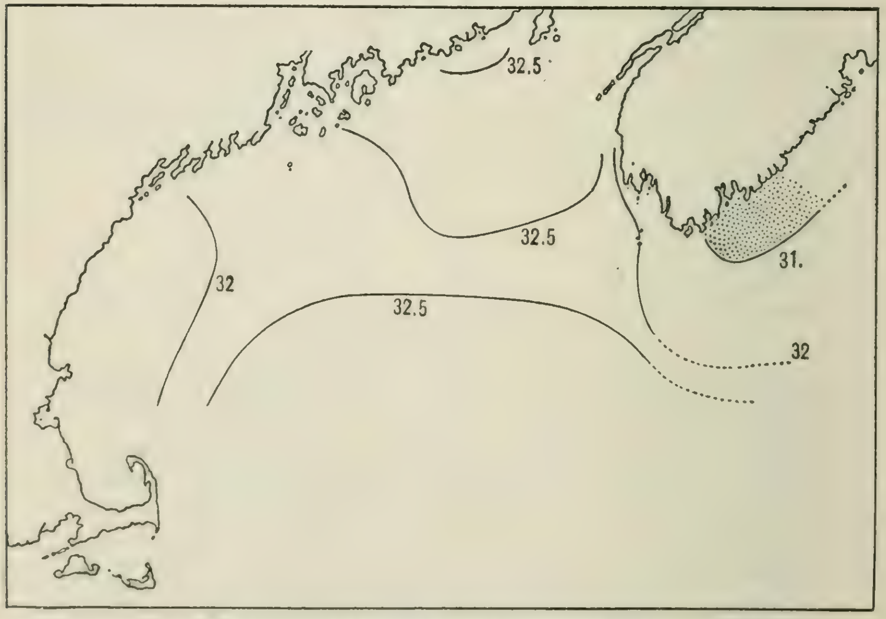
32.5
32.5
32
32.5
31.
32

FIG. 67.— Surface salinity, August 31–September 7, 1915.

2.2° (Station 10213, 70 meters), and water as cold as 4° being confined to a narrow belt next the land both at 40 meters (Fig. 59) and 100 meters.

The general salinity cycle in the Gulf of Maine is as follows:—

In March the salinity of the whole column of water, in the western part of the Gulf, is above 33‰ (1914b): during April the spring freshets lower the surface salinity along the western shore to, or below, 32‰. However, this fresh land water does not spread far offshore in early spring, for in May we found the surface of the Western Basin about 33‰ (Fig. 61), though the surface all around the shores of the Gulf, was then fresher than 32‰, this fresh belt spreading far enough eastward from Nova Scotia to include German Bank and the eastern part of the Eastern Basin (Station 10270).

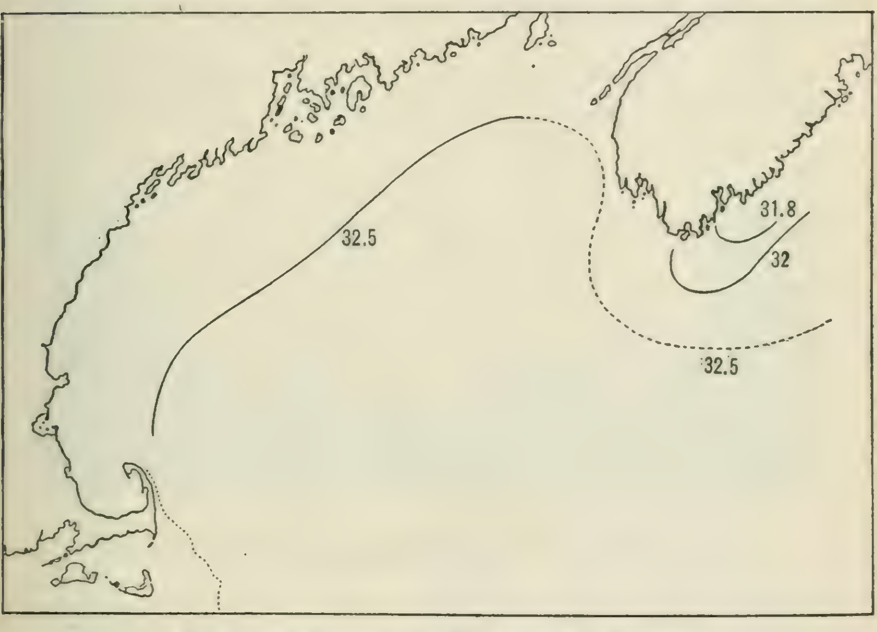

FIG. 68.— Salinity at 40 meters, August 31–September 7, 1915.

The 40 meter chart for this month (Fig. 62) shows much this same distribution of salinity, *i. e.*, high in the center of the Gulf, 32‰ or lower along the coast of Maine and from Nova Scotia to the Eastern Basin. And the salinity profile for May (Fig. 70) is especially instructive, for the curves over the eastern slope of the Gulf reveal an intrusion of water of low salinity, from the east, of which we have found no trace in summer, and which is undoubtedly the result of an influx of the Cabot Current around Cape Sable. But at, and below 100 meters, there is no evidence of it, though even at this depth the influence of the spring freshets is apparent in the western side of the Gulf (Fig. 70). As pointed out (p. 213) the water along the coast of Maine, and the Eastern Basin of the Gulf are at their freshest in, or before, May. And by June a slight rise in salinity is apparent over the eastern half of the Gulf at all depths down to 100 meters (Fig. 64–66), the expansion of 33‰ water to the east and northeast being especially striking (*cf.* Fig. 63, 66) at that level, though it does not yet reach the northern slope, as is the case in mid-summer (Fig. 34), nor has 34‰ water yet intruded beyond the Eastern Channel. The salinity curves off Nova Scotia show that the influence of the Cabot Current in the Gulf diminishes from May to June. On the surface it is entirely obliterated there by that time, though the salinity across the whole breadth of the continental shelf off Shelburne is still below 32‰ (Fig. 64). But at 40 meters (Fig. 65) the curve for 32.5‰ still suggests the presence of Cabot Current water as far west as the Eastern Basin. And off Shelburne (Fig. 74), the low salinities (31–32‰) of the Cabot Current and land water combined, still extend

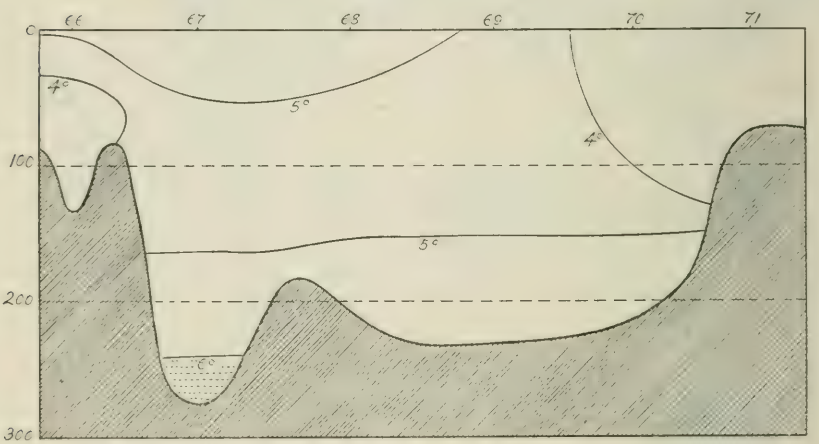

Fig. 69.— Temperature profile across the Gulf of Maine, from off Cape Ann (Station 10266) to German Bank (Station 10271), May 4–7, 1915.

across the whole breadth of the shelf in the upper layers, though with decidedly salter water below about 80 meters, thus corroborating the corresponding temperature profile (Fig. 73).

The alteration in salinity in the western side of the Gulf from May to June, *i. e.*, a decided freshening at all depths down to about 100 meters (p. 207), resulting in the disappearance of 33‰ water down to 40 meters (Fig. 70, 72), is just the reverse of what takes place in the eastern side. Below 100 meters, however, there was very little alteration in salinity from May to June (p. 207, Fig. 45) in the Western Basin.

If our September data for 1915 represent the normal salinity for that season, the summer salting of the upper layers in the eastern part of the Gulf must by then have passed its climax, and the salinity have commenced to diminish once more. On the surface, it is true, very little difference is apparent between the charts for mid-summer, and for September (Fig. 18, 67) in that region. But at 40 meters (Fig. 33, 68), the whole eastern half of the Gulf was fresher in September than in August, and there is no sign of the tongue of 33‰ water so evident in mid-summer, both in 1914 and in 1912 (1914a, pl. 2). And the same generalization holds equally for the 100 meter-level, where the September salinity of the Eastern Basin was only about 33.2‰, as against 33.6–33.8‰ in August, 1912; 33.5–34‰, in August, 1914

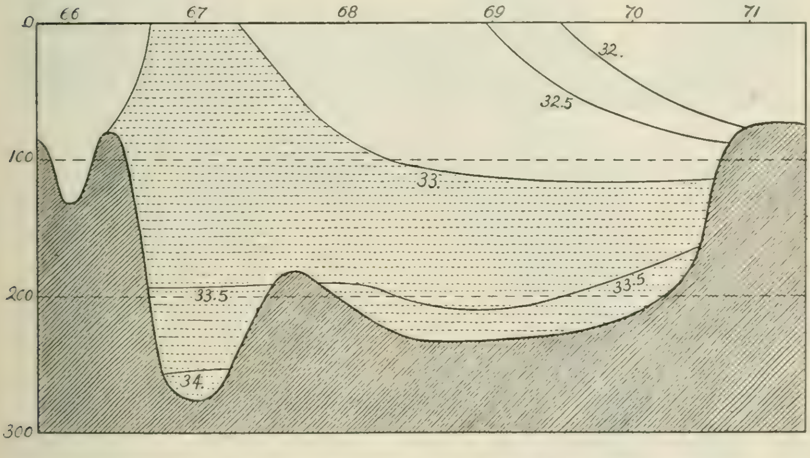

FIG. 70.— Salinity profile across the Gulf of Maine, from off Cape Ann (Station 10266) to German Bank (Station 10271), May 4–7, 1916.

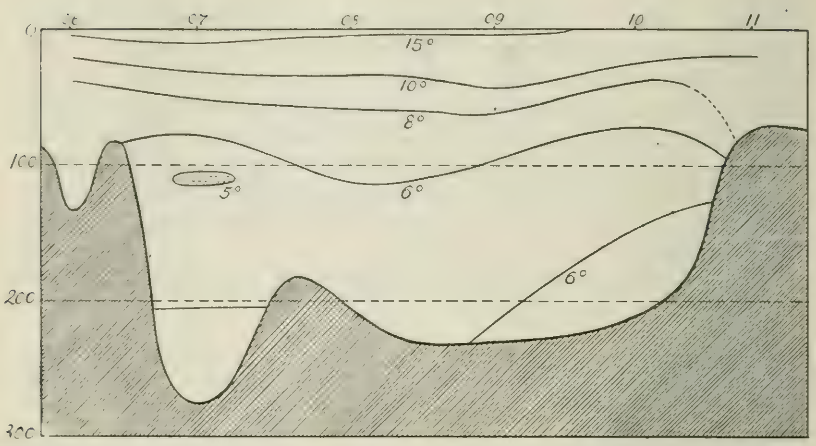

Fig. 71.— Temperature profile across the Gulf of Maine from off Cape Ann (Station 10306) to German Bank (Station 10311), August 31–September 2, 1915.

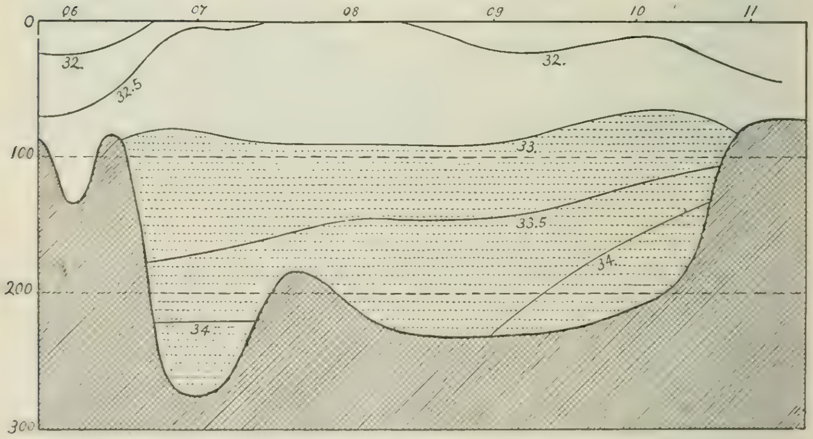

Fig. 72.— Salinity profile across the Gulf of Maine from off Cape Ann (Station 10306) to German Bank (Station 10311) August 31–September 2, 1915.

(Fig. 34, 72; 1913, Fig. 29). But this early autumn freshening (if it be a characteristic phenomenon) is confined to the eastern half of the Gulf, just the reverse being true of the western side, where the salinity of the upper layers is at, or near, its lowest in mid-summer (p. 207), with an increase of salinity already apparent on the surface by early September (Fig. 18, 42, 67). And though no great change takes place in the mid-depths from mid-summer to September, the general rise in salinity characteristic of autumn and winter (p. 207) is foreshadowed, at 100 meters, (Fig. 72) by the fact that 33‰ water reaches the western slope of the basin in September, instead of being separated from it by a band of fresher water, as in June (Fig. 66). Everywhere in the depths of the Gulf, at and below 200 meters, the salinity is higher in September than in June, particularly in the

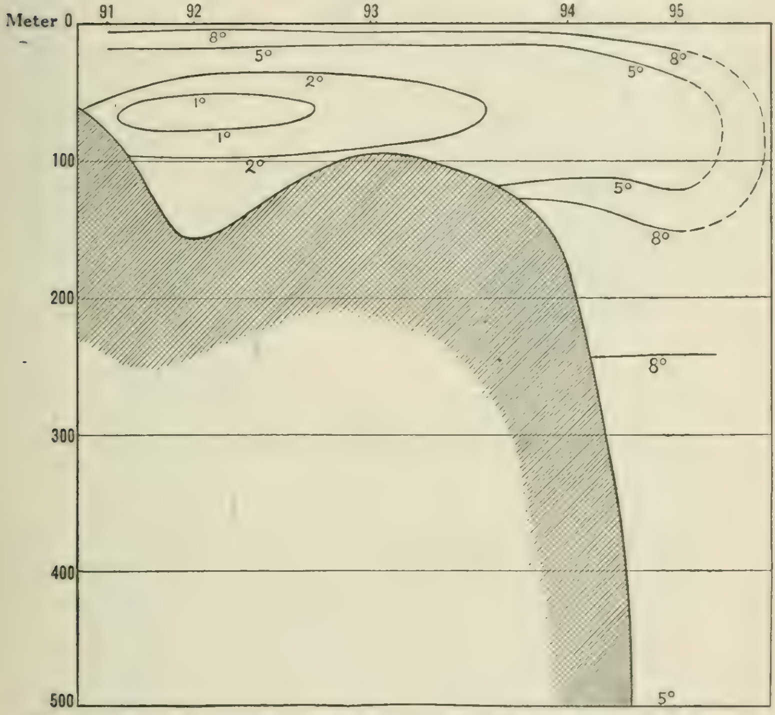

Fig. 73.— Temperature profile across the continental shelf off Shelburne, Nova Scotia, June 23, 1915 (Stations 10291–10295).

Eastern Basin, where the increase, at 200 meters, was about .6‰ in this period (33.8‰ to 34.4‰).

We have no records of seasonal changes in the eastern half of the Gulf after September; for our western stations, this has been discussed (p. 206).

Finally, I should point out that the water close to land, off Shelburne (Station 10313) was even fresher on the surface in September than in June; but it was considerably salter on the bottom; while a few miles further offshore (Station 10314), salinity as a whole rose considerably during the summer (Fig. 75, 76).

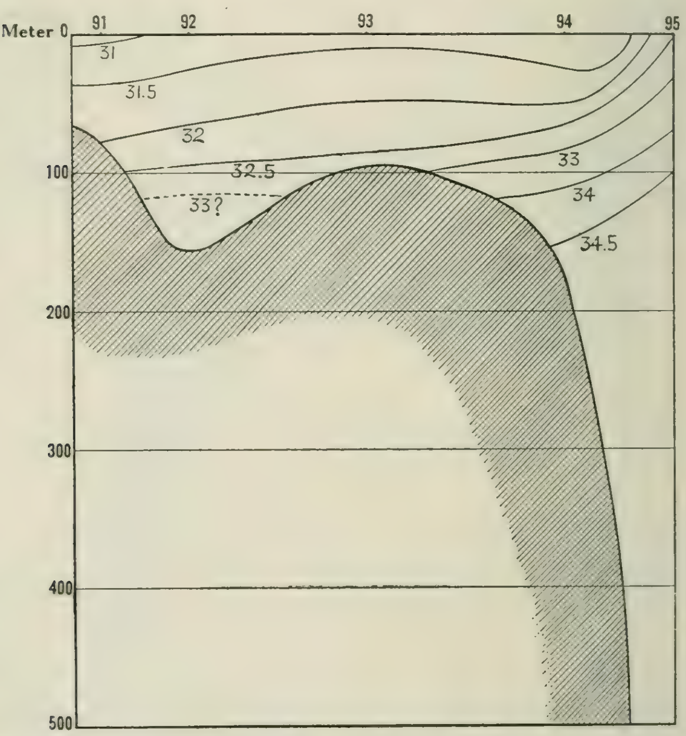

Fig. 74.— Salinity profile across the continental shelf off Shelburne, Nova Scotia, June 23, 1915 (Stations 10291–10295).

The most important seasonal change in density in the Gulf is the fact that the great vertical stability which characterizes the water in summer, practically disappears, as the upper layers cool, in winter,

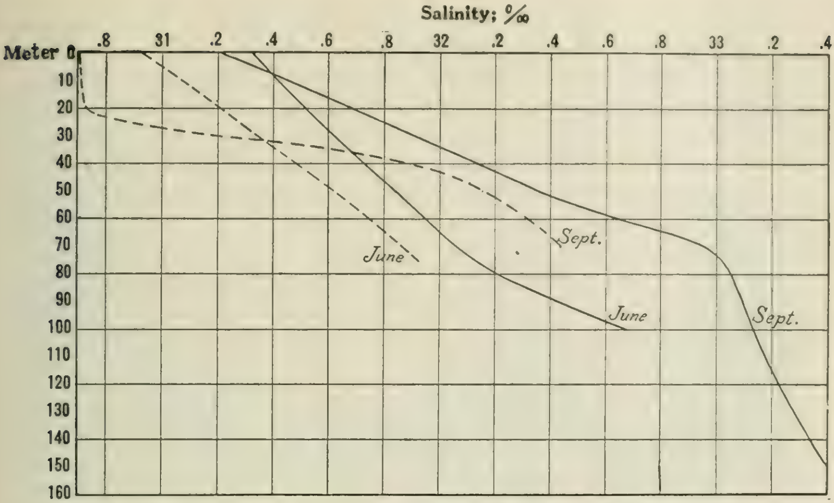

FIG. 75.— Salinity sections at corresponding pairs of localities off Shelburne, Nova Scotia, in June and September, 1915. (Stations 10291 and 10313......, 10292 and 10314, ———).

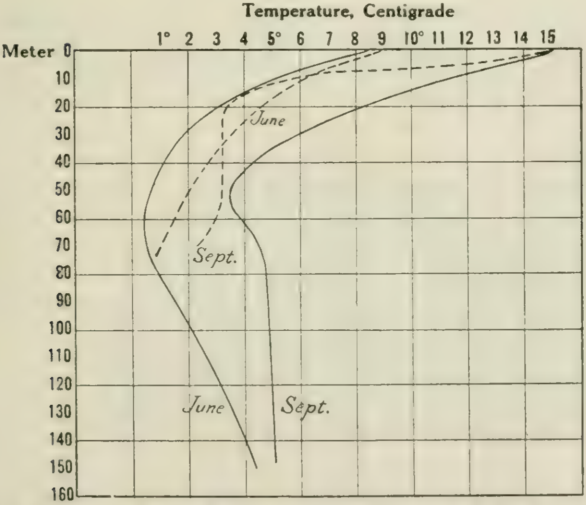

FIG. 76.— Temperature sections at corresponding localities off Shelburne, Nova Scotia, in June and September, 1915 (Stations 10291 and 10313...., 10292 and 10314, ———).

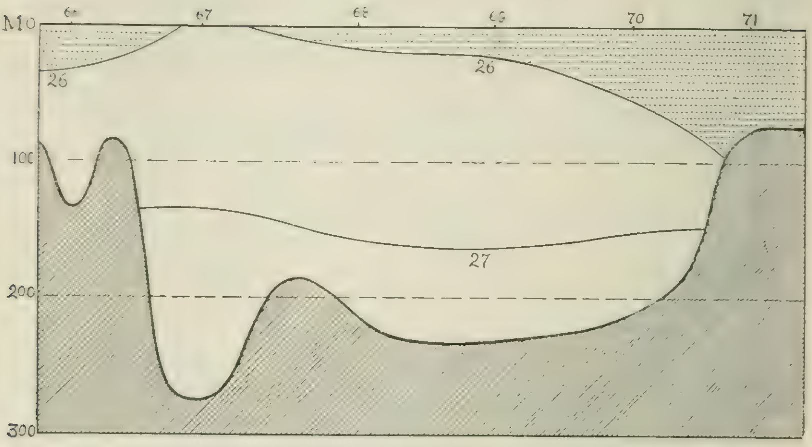

Fig. 77.— Density profile across the Gulf of Maine from Cape Ann (Station 10266 to German Bank, Station 10271). May 4–7, 1915.

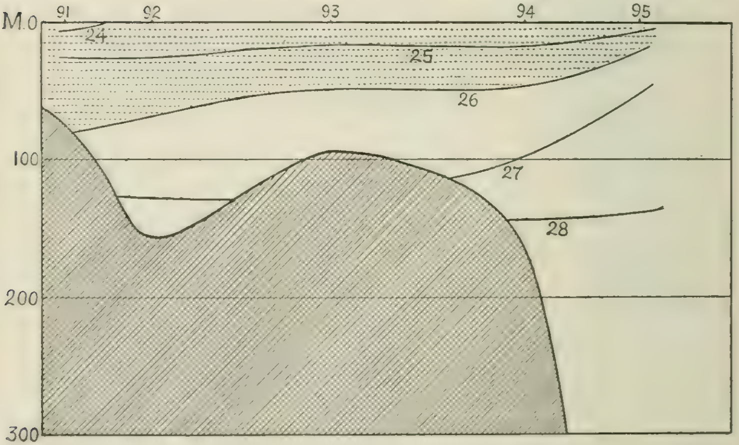

Fig. 78.— Density profile across the continental shelf off Shelburne, Nova Scotia, June 23, 1915 (Stations 10291–10295). Densities lower than 1.026, dotted.

to be gradually reestablished by the warming and freshening of the surface in spring (1914b). And density is probably comparatively uniform, horizontally, over the Gulf as a whole during the cold months, though our records for winter are limited to the neighborhood of Cape Ann. In spring, however, the inrush of land water along the northern and western shores, together with the entrance of Cabot Current water around Cape Sable (p. 224) lowers the surface density on the east and west sides of the Gulf much faster than the more gradual drop in salinity offshore, *plus* solar warming, lowers that of its center, as illustrated by a profile across the Gulf in May (Fig. 77). Particularly instructive, for its bearing on circulation (p. 242), is the fact that the cool, fresh water off Nova Scotia and on German Bank, the visible effect of the Cabot Current (p. 235), is lighter than the water it meets in the Eastern Basin of the Gulf, in spite of the higher temperature of the latter, hence floats upon it, instead of sinking into the Basin.

Even in May, the density of the bottom water of the Gulf is very uniform horizontally, west to east. And during the summer, surface density is gradually equalized until, by August a layer of water lighter than 1.026, some 70 meters thick, extends right across the Gulf (1914a, 1915).

Annual hydrographic variations in the Gulf of Maine.

The differences between the summers of 1912 and 1913 have already been discussed (1915, p. 246); in brief, the Gulf was colder and fresher in its eastern, warmer, but of about the same salinity in its western half in 1913 than in 1912.

The observations for 1913 and 1914 were made at the same season (middle of August); hence are directly comparable. But in comparing the records for 1915 with those for the preceding years, allowance must be made for seasonal change, the earlier observations having been taken in the middle of August, the most nearly comparable set for 1915 some three weeks later (September 1–19). And as pointed out (1914a), it is during just this period that the surface, in the western side of the Gulf, begins to cool, whereas on the eastern side, surface warming still continues, though the salinity of the eastern basin apparently decreases (p. 225).

On the surface the distribution of temperature was practically the same, but the absolute values were everywhere 5°–3° higher, in 1914 than in 1913 (Fig. 1; 1915, fig. 1), the only exception being locally, north of Cape Ann.

The surface salinity, on the other hand, was as a whole slightly higher in 1913 than in 1914, with a maximum difference of .8‰ off Cape Ann, .6‰ in the Western Basin, while the salt tongue which characterized the east side of the Gulf in 1913, (1915, p. 203, pl. 2), was not evident on the surface in 1914, though it was in the deeper layers (p. 196).

Taking seasonal differences into account, temperature and salinity were about the same on the surface in 1915 as the year before, the fact that the surface was considerably salter over the western basin in 1915 than in 1914 [Stations 10254 and 10255, 1914; surface salinity 31.55‰ and 31.89‰: Stations 10308 and 10307, 1915; surface salinity 32.47‰ and 32.52‰] while on German Bank and off Shelburne the reverse was true, being probably due to the difference in season between the two sets of observations; 1915 and 1914 agree in the main with 1913 in the vertical distribution of salinity and temperature, especially in the fact that the water of the central and western parts of the Gulf was coldest at about 100 meters, warmer below, instead of uniform in temperature from about 100 meters down to the bottom as in 1912 (1914a). But as a whole this vertical warming of the deeper layers was more pronounced in 1914 than either in 1913 or in 1915, as appears in the following summary of temperatures and salinities at corresponding localities from summer to summer.[1]

Off Cape Ann the salinity was lower at all depths in 1914 and 1915, which were almost exactly alike, than in 1912 or 1913, the differences between 1914 and 1912, which was the fresher of the two previous years, being .4–.5‰. But the greatest temperature difference between the three years, at any level below 20 meters, was less than 1°.

Except for the immediate surface, so subject to seasonal change, the Western Basin was warmer down to 100 meters in 1915 than in any previous year of record; below that depth the temperatures for 1915 are, as a whole fractionally cooler than those for either 1913 or 1914, warmer than 1912; though with an extreme variation of only about 2.4°. In 1913, 1914, and 1915 the water was coldest at about 100 meters (p. 167); in 1912 the temperature was uniform from 120 meters down to the bottom. Salinity here was about the same in 1913 as in 1912 (1915, p. 204); from .66‰ to .42‰ lower in the upper layers in 1914 than in 1912 or 1913 (1915, p. 204); with 1915 slightly the saltest year of the four down to 40 meters (a difference probably seasonal); below 200 meters salinity was about the same in all four years.

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[1] See tables p. 333.

The center of the Gulf, near Cashe's Ledge, was 2°–3° warmer near the surface, colder below 40 meters in 1914 than in 1913, with 1915 intermediate between the two below 80 meters. But these differences may be due to varying vertical circulation at different distances from the Bank, as may the fact that the water was coldest on the bottom in 1915, instead of at 100 meters, as in 1913 and 1914. Salinity was lower here at all depths, in 1914 than in 1913, with 1915 intermediate, the extreme variation being about .46‰.

In the western side of the Eastern Basin temperatures changed only fractionally from 1912 to 1915 (apart from seasonal disturbances); but salinity decreased from 1912 to 1914, at all depths, with an alteration of .75‰ on the surface; .4‰ at 40 meters; .63‰ at 100 meters; .35‰ at 180 meters; and though 1915 apparently shows a tendency toward the reestablishment of the earlier state, being intermediate between 1914 and 1913, this may be a seasonal phenomenon (p. 225).

On German Bank both temperature and salinity were about the same in 1914 and 1915, (seasonal differences considered, p. 205) as in 1912, correspondingly warmer than in 1913 (1915).

This comparison may be further extended, for 1912, 1913, and 1914 to the northern part of the Gulf and to its northern coastal zone, where no late summer, or early autumn records are available for 1915. The northern part of the Eastern Basin was colder, down to 120 meters, in 1914 than in either 1912 or 1913, warmer, below 120 meters; as it was off Mt. Desert Rock also. It was saltest in 1914, freshest in 1913, with a difference of .64‰ at 60 meters. Along the northeast coast of Maine, however, both temperature and salinity as a whole varied but little from year to year, though the vertical range of both was greatest in 1914. But west of Penobscot Bay the water next the land was, as a whole, colder, and fresher, in 1914 than in either 1912 or 1913, as exemplified by our stations off Matinicus Island, and off Cape Elizabeth; this is also true of the deep trough west of Jeffrey's Ledge, though at that locality the difference in temperature was limited to the deeper layers, below about 75 meters.

Thus, except for the immediate surface, the upper 150 meters in the whole western, central, and northern part of the Gulf was slightly colder and considerably fresher, in 1914 than in either of the preceding years. On the contrary, the bottom of the Western Basin and the northern and eastern parts of the Eastern Basin as a whole were just the reverse, *i. e.*, warmer and salter in 1914 than in either 1913 or 1912, with still higher temperatures and salinities in the former in 1915.

In a partially enclosed basin, subject to such violent climatic changes as is the Gulf of Maine, and where waters of such different temperatures and salinities struggle for the mastery, more or less fluctuation in hydrography is to be expected from year to year. But our data are now sufficient to show that such changes as do take place are very small; and nothing has yet transpired to suggest that they ever seriously affect the waters of the Gulf one way or the other, as a biologic environment. That violent fluctuations may occur at rare intervals, is of course possible; that they do so, along the edge of the continental slope can not be disputed (1915, p. 265), but we still await evidence of such events in the Gulf.

Origin and Circulation of the Gulf of Maine Water.

The explorations in 1912 (1914a) and 1913 (1915) showed that the waters of the Gulf of Maine are complex, land water, Gulf Stream water, and St. Lawrence water all taking part in their formation, while the possibility that abyssal water might also enter, by upwelling, into this complex has also been recognized. But the data for those years was not sufficient to throw much light on the proportions in which these different waters meet in the Gulf; or to disclose the precise inflowing or outflowing currents, beyond the fact that there is an indraught on its east, and an outdraught on the west side (1914a, p. 91; 1915, p. 231). The data for 1914 and 1915 advance our knowledge of these questions, particularly as to the origin and extent of the northern current. It is clear, indeed the early records demonstrated, that the summer temperatures of the Gulf are not much affected by cold northern currents, being nearly what would be expected if it were an enclosed basin; the Gulf owes its low temperature chiefly to the cold winter climate of the neighboring land mass. But salinities, plankton, and the general set of the currents, show beyond question, that a northern current does reach the eastern side of the Gulf, though so mixed with Atlantic water that its hydrographic influence is hardly appreciable; and some information is at hand as to its seasonal variations.

One of the first, and most important conclusions, drawn from our early work was that the northern water on our coast is chiefly of Gulf of St. Lawrence, not of Labrador Current origin; and as the general theoretic reasons for this view are discussed elsewhere, 1915, p. 251, Schott, 1897, Krummel, 1911), I need only point out here how fully the records for 1914 and 1915 bear it out.

Salinities (p. 182), temperatures (p. 174), and current records (p.

203) combined, reveal an unmistakable current, flowing from northeast to southwest, along the southeast coast of Nova Scotia in August, 1914, with a velocity of 1 knot per hour, only 30 miles from the entrance to the Gulf of Maine; and though this current was both narrow (about 15 miles broad off Halifax) and superficial, it was easily distinguishable from the salter, warmer, water which bounded it on the sea side. Its most characteristic feature is, of course, its very low temperature below the level to which solar warming had penetrated (p. 171). This, with its direction of flow, and the fact that its plankton contained such typically Arctic components as *Limacina helicina* (p. 248) and *Mertensia ovum* (p. 248), shows that it actually was the southern extension of some current from the north.

In this part of the world, such fresh and at the same time icy cold, northern water can have only one of two origins, *i. e.*, from the Gulf of St. Lawrence, or from the Labrador Current. Considering that it was encountered all along the coast from Halifax to Cape Sable, hugging the land closely; and that there is an important and well-known outflow from the Gulf of St. Lawrence along the west side of Cabot Straits, the Cabot Current, (1915, p. 253, Schott, 1897; Dawson, 1896, 1913), the natural presumption would be that our Nova Scotia current is the direct continuation of the latter.

Actual hydrography further supports this contention, for both in salinity, in minimum temperature, in the degree to which solar warming progresses in summer in the surface layers, in the level at which the temperature is at its minimum, and in the superficiality of the cold water our Nova Scotia Current agrees very closely with the outflow in Cabot Straits, as well as with the neighboring parts of the Gulf of St. Lawrence (Dawson, 1913), with which it is actually continuous both in temperature (Townsend, 1901), and in salinity (Dickson, 1901). Furthermore, the fact that we found the Nova Scotia Current in the same location, and with about the same physical characters in two successive years, shows that it was not a sporadic phenomenon, but a regular characteristic of the summer hydrography of the coast. In short, the demonstration that it is a southward extension of the Cabot Current is as complete as hydrographic evidence, other than the actual drifts of bouys, can make it. This, however, does not forbid the possibility that it receives water from the Labrador Current, as the result of a southwest flow across the Grand Banks.

It is now well known that a certain amount of Labrador water enters the Gulf of St. Lawrence via the south coast of Newfoundland and the east side of Cabot Straits (Schott, 1897, 1912; Matthews, 1914). But this is so small in amount, and becomes so thoroughly mixed within the Gulf that it has no appreciable effect on the outflowing Cabot Current. Fortunately the physical characters of the latter, and of Labrador Current water are now fairly well known, thanks to Dawson's records (1896, 1913), to the work of the Scotia (Matthews, 1914), and of the Seneca (U. S. Coast Guard, 1915). According to Dawson (1913) the minimum temperature of the Cabot Current in Cabot Straits is from −.5° to +.5°. On Banquereau Bank the minimum is about −.1°; off Halifax −.2° to 1° in May (U. S. Coast Guard, 1915, Seneca Stations 14–17), while it is only fractionally higher (.7°–1°) off Shelburne in June (p. 217). And only a very slight warming takes place, at the level of minimum temperature, even by midsummer. The salinity of the cold water along the Nova Scotian coast is correspondingly low, and constant, that of the coldest layer (50–75 meters) 31‰–32.3‰, its average about 31.9‰.[1] The Labrador Current is even colder than the Cabot Current, its temperature being about − 1.6°, when not influenced by solar warming, or by mixture with Atlantic water (Matthews, 1914); and even in July its surface warms only to about 7°. For example, at Seneca Station 74, east of the Grand Bank, July 25th, the temperature was 7.9° on the surface; about 0° at 20 fathoms, −1.6° at 50 fathoms (U. S. Coast Guard, 1915, p. 60).

It is also much salter, its characteristic salinity upwards of 32.5‰, according to Matthews (1914), while even along its inner western edge, where most influenced by river-flow from the land, its surface salinity hardly falls below 32‰ (minimum about 31.9‰, Matthews, 1914). Both the Scotia and the Seneca records show that the salinity is upwards of 32.5‰ on the Grand Banks, except close to the south coast of Newfoundland where the surface is fresher owing to land drainage.

From this it appears that did any considerable amount of unadulterated Labrador water join the Nova Scotia coast current, the temperature of the latter would be lower, its salinity higher, than in Cabot Straits. True, a junction of Labrador with St. Lawrence water might take place without altering the temperature of the latter at all, were the former sufficiently mixed with warm Atlantic water, during its transit from the Grand Banks to Nova Scotia, to raise its tempera-

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[1]			
Banquereau Bank	April	31.8‰	Seneca Station 17
Off Halifax	April	31.67–32.1‰	Seneca Station 14, 15
" "	Aug.	32.09–32.3‰	
" Shelburne	June	31.8–32‰	
" "	Aug.	31.9–32.2‰	
Sable Island Bank	April	31.7–31.9‰	Seneca Station 13

ture by 1°–2°. But this would necessarily raise its salinity as well, Atlantic water being considerably salter even than Labrador water, as demonstrated by the SENECA and SCOTIA stations off the southeast corner of the Grand Bank. Hence, if any large amount of mixed water of this sort reached Nova Scotia, its effect would be even more unmistakable, in raising the salinity of the coast current, than that of pure Labrador water, even if temperature did not betray it. But we have found nothing of the sort, low salinity prevailing all along the coast from Cabot Strait (Dawson, 1913) to Banquereau (p. 236) and thence to Shelburne (p. 182). Furthermore, the work of the SENECA failed to reveal any dominant flow to the southwest across the Grand Banks, the current there being tidal (Schott, 1897, Johnston, 1913, 1915). In short, hydrography argues against the idea that the Labrador Current exerts any direct influence on the Nova Scotian long-shore current; if it does, it is insufficient to have any appreciable effect on the salinity or temperature of the latter.

This is an appropriate place to point out, what the hydrography of the outflow from the Gulf of St. Lawrence proves, that the mere existence of a minimum temperature layer even as cold as 0° in summer at 100 meters or so, with warmer water above and below, is not a criterion for the presence of polar water. True, such a minimum temperature layer is characteristic of polar waters (Nansen, 1902; Helland-Hansen, and Nansen, 1909; Knudsen, 1899; Matthews, 1914). But it can be equally produced in partially enclosed coastal waters, where the surface layers are subject to an extremely rigorous winter climate, alternating with considerable solar warming in summer; and where at the same time, the depth of water is great enough to allow a more or less constant inflow of warmer ocean water below the depth to which winter cooling penetrates. Thus, in the Gulf of St. Lawrence, local air temperatures, without any considerable accessions of polar water (Dawson, 1907, Krummel, 1907), produce a vertical range of temperature in summer from 15°–18° on the surface to about .56° to 1.1° at 100 meters, warming to about 4.4° at 400 meters (Dawson, 1913); and a similar, though less pronounced minimum layer obtains, in some summers, even in the Gulf of Maine (p. 222), due to the same causes. But wherever such a minimum layer is colder than about −1°, as is the case in the Labrador Current (Matthews, 1914) it is positive evidence of Polar water, for nowhere, on either side of the North Atlantic, does winter cooling alone produce such a low temperature.

In the present connection the important feature of the Cabot Current is its effect on the Gulf of Maine. Although the Current is narrow and superficial (not over 20 miles broad, or 50 meters deep off Halifax in summer), its velocity is considerable, and it persists at least from spring to early autumn. Hence, since it retains its very low temperature and salinity as far west as Shelburne, only 30 miles from the entrance of the Gulf, it might be expected to produce the same subarctic hydrography all around the northern shore of the latter, as obtains off Halifax and Shelburne, did it enter the Gulf unaltered. But nothing is more certain, from our four years work than that such is not the case, the Gulf being hardly colder, or fresher, than if no northern water reached it. And, at least in summer, its eastern side, most open to the effects of the Cabot Current, is actually warmer and salter than its western. Furthermore the Cabot Current influences the hydrography of the western side of the Gulf no more in winter than in summer; and even in May, when it is apparently at its maximum, the eastern part of the Gulf is of about the same temperature, except for the immediate surface, as the western, decidedly warmer than the water is off Shelburne, only thirty miles away. The fact that the Cabot Current chills the eastern part of the Gulf so little, contrasted with the very low temperature caused by it only a few miles east of Cape Sable, suggests that such of it as enters the Gulf, is mixed with warmer water from offshore; and this is confirmed by our salinity records for 1914 and 1915. To begin with, the charts (Fig. 33, 34), show clearly that only a minor part of the current reaches the Gulf, even in June its main body swinging seaward off Shelburne (p. 217); and the smaller branch which does pass Cape Sable, mixes on German Bank with the much greater volume of warmer and salter offshore water which enters the eastern side of the Gulf in summer. And, in summer at least, the resultant mixture is as a whole salter, and warmer than the western part of the Gulf, though the latter is less subject to disturbances from outside.

The influence of the Cabot Current, in the Gulf, is most evident at about 40 meters (Fig. 30, 33), its effect on temperature and salinity being limited to the upper 100 meters, even when at its maximum (p. 224); and it is certain that though it flows southward along the eastern slope of Brown's Bank in summer, it neither crosses the latter, nor follows it around to the west at that season, but exhibits a greater and greater tendency to recurve upon itself off Shelburne as the depth increases, the Eastern Channel being much warmer and salter.

The warm salt tongue detected in the eastern part of the Gulf in 1912 (1914a) has been confirmed by more recent studies (1915). But the fact that its salinity and temperature are both considerably below that of Gulf Stream water, though the latter is encountered in full purity close to the continental slope (p. 190), and that it does not bring with it a tropical, or Gulf Stream plankton, but only the more resistant warm-water forms, shows that it is not true Atlantic water, but the mixed-water resulting from the conflict between the inner edge of the Gulf Stream and the coast water, which takes place all along the continental slope, from Nova Scotia to Chesapeake Bay (1915). That this is the case is further supported by destiny, for mixed water, being heavier (below the level of the southern rim of the Gulf), than Gulf water (p. 202) would naturally flow into the basin of the Gulf via the Eastern Channel, by the ordinary estuarine type of circulation, and being equally heavier than Gulf Stream water at this critical level (p. 202), bars the latter from reaching the Eastern Channel. This influx, apparently at its height in late summer and early autumn, has little effect on surface temperatures or salinities. But at, and below 40 meters salinities reveal it very clearly as a tongue entering the Gulf through the Eastern Channel, crossing Brown's Bank where it meets the south and west flowing Cabot Current, thence following the eastern slope of the Gulf, to turn westward along the coast of Maine, as already described (p. 96). As depth increases it more and more nearly approaches undiluted ocean water in its characteristics. But the gradual decrease in its salinity from southeast to northwest, even in the deepest parts of the Gulf where it receives no accessions of Cabot Current water (p. 190), is evidence of a constant mixture with the fresher water of the Gulf. It is possible that pure Gulf Stream water may sporadically reach the Gulf across the western end of Georges Bank, just as it approaches the land, locally, and temporarily, west and south of Cape Cod (1915). But no actual instances of this have yet been observed, nor do the densities on the two sides, north and south, of Georges Bank, (p. 202), suggest any tendency toward it, at least in summer.

The third import source of the Gulf water is the influx from the rivers which empty into it. And as I have already pointed out (1914a, p. 96), this is so great in amount that it would of itself be sufficient to raise the level of the Gulf about half a fathom per year, were the latter an enclosed basin. Finally, the possibility of an upwelling of water from the Atlantic abyss into the Gulf, must be recognized, less because of any actual probability of it, than because circulation of this sort has often been invoked to explain the low temperature of our coast, as contrasted with Atlantic, water (1915).

That abyssal water does not enter to any great extent into our

Gulf was evident from our early work there (1914a), Gulf salinity being far too low. And on the cruise of 1913 we failed to find any upwelling of this sort west of Cape Cod (1915, p. 260); a generalization which can now be extended to the whole slope from Cape Cod east to Halifax at least in summer; for we found none of the criteria, *e. g.*, lowered surface temperature, and vertical uniformity of salinity down to the level from which upwelling takes place, which would betray such a process. On the contrary, the abyssal water all along the slope, from off Marthas Vineyard to the Eastern Channel is bounded above by a much warmer (8°–10°) and salter (35‰+) bottom zone, from 100 to 300 meters thick, (Fig. 8, 9, 14; 26, 27, 32), just such as characterizes corresponding profiles west and south of Cape Cod (1915). And this could not have been the case, had upwelling been taking place up the slope. Off Shelburne, too, the abyssal water was separated from the even colder Cabot Current by a warmer bottom zone (5°–8°) between 120 and 400 meters, both in 1914 and in 1915 (Fig. 11, 73), though the zone of high salinity did not reappear there. In short, there is no reason to suppose that abyssal water wells up the slope, on to the continental shelf, anywhere between southern Nova Scotia and Chesapeake Bay, in summer.[1] Nor do the winter temperatures and salinities of the Gulf afford any more evidence of the presence of abyssal water there at that season.

Tidal currents are so strong in the Gulf as to obscure the dominant circulation during most of the year (1914a, p. 83). But salinities, particularly the salt tongue in the east (p. 196), and plankton (p. 246) combined, suggest that the main axis of the eddy-like drift which occupies the Gulf is close to the land, which it follows, from east to north and west, sometimes with seaward expansions off Penobscot Bay and Cape Ann, the direct product of river freshets (1914a, 1915, pl. 2).

It is obvious that there must be a considerable outflow from the inshore part of the Gulf, to offset the great amount of river water, (p. 239), besides the increments of offshore and of Cabot Current water, which enter it. Our earlier work suggests that the overflow takes place chiefly along the west side, past Cape Cod; though with no definite current there, but rather a gradual fan-like drift through the South Channel, to Nantucket Shoals, and Georges Bank. But this process is not wholly restricted to the west side of the Gulf, the cool fresh band (Fig. 8), which was encountered on the eastern end of Georges Bank in 1914 being hard to explain, except as an outflowing current from the Gulf. Whether, however, this is a regular, or a sporadic phenomenon, is yet to be learned.

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[1] Account is only taken here of the upper zone of the slope, above the 500 meter-level, *i. e.*, of upwelling which might affect the coast water.

The seasonal cycle of temperature and salinity, (p. 205) indicates the following fluctuations in the relative importance of the several waters in the Gulf of Maine, from season to season.

River water is at its minimum in February and March (1914b), when the salinity, at least in the western part of the Gulf (where alone it is known at that season) is at its maximum (1914b). But, as a result of the freshets of early spring, it suddenly assumes great importance in April, as evidenced by the sudden freshening which takes place all along the coast west of Penobscot Bay (1914b), and which probably includes the coastal zone east of the latter as well; and local variations in salinity show (1914a, p. 91, 1914b, p. 402) that there is then a distinct along-shore current from northeast to southwest, the result of the successive increments of fresh water added by the various rivers, which I have myself found very noticeable as it flows past Cape Ann. The actual freshets are ended by May (though the river flow is considerable throughout the year), when salinity immediately next the land is at its minimum, (p. 213; 1914b, p. 393).

North of Cape Ann, the visible effect of the freshets hardly survives its immediate cause, as evidenced by the rise in salinity which takes place along the coast in June; and this is probably more or less true everywhere within two or three miles of land, owing to the frequent upwelling of bottom water, caused by offshore winds (1914b). But river water is increasingly evident throughout the late spring and early summer, off Massachusetts Bay, and over the Western Basin, where the immediate effects of the freshets are less pronounced, not reaching its maximum, even within 8–10 miles of Cape Ann until August (p. 207, Fig. 42); and at least in some years, it then appears as a distinct tongue extending eastward from Cape Ann (1914a, pl. 2), or as a general fresh area off Massachusetts Bay (Fig. 18). Even here, however, it dwindles very rapidly in importance in late summer and early autumn (Fig. 42, 47).

In the Gulf, river water is always most in evidence at and near the surface, as might be expected; and it has very little effect below 100 meters, except close to land.

So far as our data go, northern, like river water, is at its maximum in the Gulf in early May, when we encountered a current running westward past Cape Sable into the Gulf, unmistakably identified by its low salinity and temperature, and by the Arctic members of its plankton (p. 248), as a branch of the Cabot Current. At that season its effect is traceable as far west as the Eastern Basin of the Gulf; and its main line of dispersal was evidently west, not north toward the Bay of Fundy, neither salinity (Fig. 65), temperature (Fig. 53) nor plankton (p. 248, Fig. 81) affording any evidence of it north of Yarmouth, off the west coast of Nova Scotia. This branch of the Cabot Current dwindles rapidly as the season progresses. In June there is very little evidence of it, either in salinity or temperature, on the surface of the Gulf (Fig. 89), while the area then influenced by it in the mid-depths (32.5‰) is less extensive than in May. And in August and September no trace of it has been detected west of Cape Sable, at any depth. In the latter month the main branch of the Cabot Current still reaches Brown's Bank and the Northern Channel (p. 22). But it is so much narrower off Shelburne then than in June, or in August, as to suggest its entire obliteration there in autumn.

No satisfactory records of the winter temperatures and salinities of the eastern half of the Gulf (1914a, 1915), are yet available. But the facts that river freshets, and melting ice indicate a spring or early summer maximum for the outflow from the Gulf of St. Lawrence, and that there is nothing in the winter temperatures salinities or plankton of the western side of the Gulf (1914b) to suggest the influence of the Cabot Current, together with its fluctuations as just outlined, forbid the idea that it enters into the Gulf in appreciable amount at any season except spring.

I have already pointed out (p. 238) that the branch of the Cabot Current which reaches the Gulf is very superficial, due to its comparatively low density, hardly influencing hydrography below, say, 50 meters; and since this low density is retained by this northern water as long as it is recognizable in the Gulf, there is no reason to suppose that it ever sinks into the basin of the latter, which explains not only the comparatively high bottom temperatures of the basins, but the absence of Arctic elements in the plankton there.

The relative importance of offshore water, is, roughly, the reverse of that of river, and of the Cabot Current water, of which it is the antithesis in salinity, increasing from spring to summer as the latter dwindle. It is certain that the influx takes place chiefly in the eastern side of the Gulf (p. 238): and our records, so far as they go, suggest that in the upper layers it is at its maximum there in August (p. 225); diminishing in autumn. But we know so little about the hydrography of the eastern half of the Gulf in the latter season, or winter, that possibly other definite intrusions of the sort may occur later in the season.

In the deeper layers, particularly near the bottom, this process probably takes place more or less at all seasons. But although the salinity of the western side of the Gulf rises during the winter (p. 206; 1914b), the fact that the mean salinity is no higher off Cape Ann, or on the northwest part of Georges Bank in early spring, than off Mt. Desert in August, is good evidence that no general flooding of the Gulf by offshore, or Gulf Stream water, takes place during the winter. The hydrographic history of that season is, rather, one of general equalization, horizontal as well as vertical (1914b), the eddy-like circulation of the Gulf gradually bringing salter and salter water to its western side, as the land water gradually mixes with the higher salinities in its center. In short the Gulf is probably more nearly stagnant, if that term can fairly be applied to the open sea, in the winter than at any other time.

The comparative constancy of salinity, temperature, and character of plankton in the Gulf, since 1912 (p. 231), is good evidence that there has been no general alteration of the circulatory scheme here outlined, *i. e.*, no important sporadic floodings by either Gulf Stream or by Cabot Current water during the four year period. But the annual hydrographic variations described above (p. 231) show that there have been small fluctuations in the relative importance of these waters in the Gulf from year to year. Thus only a relatively lesser amount of offshore water can account for the low salinity of the eastern part of the Gulf in 1913 as compared with 1912, 1915. And offshore water was relatively less important in the western part in 1914 than in 1912; though it is not clear whether this was due to an increased amount of land water, to St. Lawrence water, or to an actual diminution in the inflow via the Eastern Channel. By 1915 we once more found the conditions of 1912 reestablished there.

PLANKTON.

General Character of the Macroplankton.— The summer plankton of the Gulf of Maine was of the same general type in 1914 as in previous years (1914a, 1915), Copepods, chiefly Calanus and Pseudocalanus, predominating, with smaller numbers of hyperiid amphipods (Euthemisto, p. 286), euphausiids (Meganyctiphanes and Thysanoessa, p. 281), pteropods (Limacina, p. 298), Sagittae (p. 294), and other boreal animals. The only important variation from this general plankton type was on German Bank (Station 10244) where we encountered the Pleurobranchia swarm which appears to characterize that locality (p. 249; 1914a; 1915); and these same copepods formed the bulk of the plankton over the continental shelf off Marthas Vineyard, and on the eastern part of Georges Bank, while they were one of its important constituents off Shelburne (Fig. 79). But very few were taken in the waters over the continental slope; in the Eastern Channel or off Halifax.

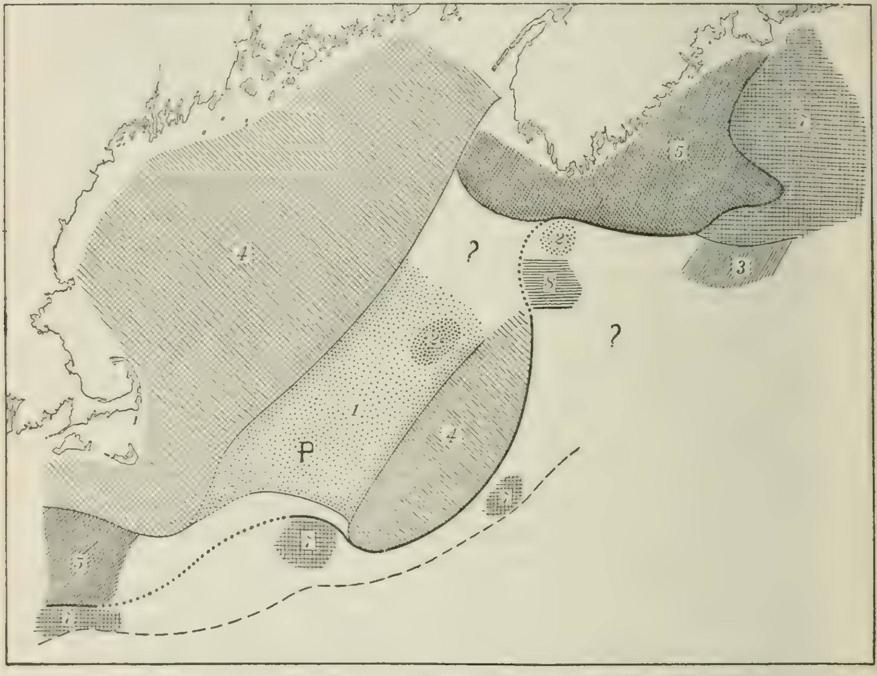

FIG. 79.— Predominant types of macroplankton, July–August, 1914.
1, Copepod and Sagitta; 2, Sagitta swarms; 3, Euphausiid; 4, Copepod; 5, Copepod and amphipod; 7, Amphipod; 8, Amphipod and euphausiid; P, Pteropod swarm; ▬▬▬, offshore limit to copepods as an important factor: ------, Northern limit to predominant tropical plankton.

Sagittae (p. 294) were as important, faunally, as copepods, over the central part of Georges Bank and in the Northern Channel; amphipods near the land off Shelburne and Cape Sable (p. 286, Fig. 79); and the latter (Euthemisto) composed the bulk of the plankton (Fig. 79) in the waters along the outer edge of the shelf off Marthas Vineyard, on the outer part of Georges Bank and off Halifax; while euphausiids played a similar rôle on Brown's Bank, (Station 10228) and over the slope south of Shelburne (Station 10233).

Previous experience (1915) leads us to expect Gulf Stream temperatures and at least a large admixture of Gulf Stream fauna over the continental slope all the way from Chesapeake Bay to Cape Cod; and 1914 was no exception to this general rule. Thus, we encountered a tropical plankton assemblage over the slope off the west end of Georges Bank (Station 10218), including the fishes Leptocephalus and Myctophum; *Salpa fusiformis* and Doliolum; the tropical amphipods Phronima, Vibilia and Oxycephalus: the copepods Rhincalanus and Sapphirina: *Sagitta enflata, S. hexaptera* and *Pterosagitta draco* (p. 294); eleven species of tropical pteropods (p. 302) and nineteen species of tropical Medusae and Siphonophores, (p. 306); likewise Gulf weed (Sargassum), floating on the surface. And Doliolum, Phronima, a phyllosome larva and a tropical pteropod (p. 302) occurred in the otherwise typically boreal plankton on the edge of Georges Bank near Station 10219.

At the same relative position on the slope, 100 miles further east (Station 10220) the rather scanty catches were almost evenly divided between boreal organisms, (*e. g.*, Euthemistio, Aglantha, *Limacina balea*) and animals of Gulf Stream origin (Euphausia, Nematoscelis, Rhincalanus, a phyllosome larva, Phronima, Doliolum) while this Station was further noteworthy for the occurrence of several specimens of *Diphyes arctica* (p. 306), which likewise occurred over the slope off Shelburne in June, 1915.[1] The plankton over the slope off Marthas Vineyard, in August (Station 10260, 10261) was similarly divided between boreal and tropical organisms, the hauls consisting chiefly of Euthemisto, with occasional *Limacina balea*, side by side with such warm water forms as Myctophum, Phronima, and *Sagitta enflata.* But at the same relative position on the slope off Shelburne (Station 10233) the plankton was chiefly boreal, *e. g., Sagitta elegans*, Euthemisto, Clione, *Calanus finmarchicus, C. hyperboreus*, Euchaeta, *Limacina balea*, and Aglantha, as might be expected from the hydrography (p. 177), with only a minor tropical element (the copepod Rhincalanus in 1914; *Sagitta enflata* and the fishes Cyclothone and Valencienellus in June, 1915).

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[1] The geographical relations of *D. arctica* are discussed (p. 306).

Tropical organisms have rarely been found in the plankton in the Gulf of Maine, the only examples, from previous GRAMPUS cruises, being as follows:— *Thysanoessa gregaria* at several localities (1914b, p. 411), *Salpa fusiformis* and *Physophora hydrostatica* near German Bank, *Salpa mucronata* off Cape Cod, and in the northeastern part of the Gulf in the summer of 1912 (1914a, p. 103, 121; 1915), and *Salpa tilesii* in Massachusetts Bay, in December, 1913. To this brief list the cruise of 1914 adds the following:— Rhincalanus in the southeast corner of the Gulf (Station 10225) and *Thysanoessa gregaria* (p. 282) in its western side (Station 10254), on Brown's Bank (Station 10228) and in the Northern Channel (Station 10229). In 1915 Rhincalanus was detected twice in the northeastern corner of the Gulf in May (Station 10272, 10273): Physalia once in the Eastern Basin (near Station 10288); and even more interesting, a bit of Gulf weed (Sargassum) was picked up on German Bank in September (Station 10211).

Three other forms, the copepods, Pleuromamma and Eucheirella, and a pteropod, *Diacria trispinosa* (1915, p. 302) while oceanic-Atlantic rather than typically tropical, (Scott, 1911; Cleve, 1900); may be classed in the latter category so far as the Gulf is concerned, since they undoubtedly enter it from the inner edge of the Gulf Stream, and, judging from their rarity, have not been able to establish themselves there. Eucheirella occurred twice in 1912, (1914a, p. 116); twice in 1913; twice in the Gulf proper in 1914; twice in 1915 (Stations 10270, 10310, a total of four specimens): Pleuromamma was taken once in 1913 (1915, p. 288): Diacria once in 1913 (1915, p. 302).

Judging from these records, visitors from the inner edge of the Gulf Stream may be expected anywhere in the Gulf, at any season. But, as the chart (Fig. 80) shows, they have been encountered most frequently in its eastern part although fewer hauls have been made there than in the west, *i. e.*, just where hydrography is most influenced by the influx of ocean water (p. 238).

The rarity of warm water animals in the Gulf of Maine contrasted with the very rich tropical fauna which inhabits the inner edge of the Gulf Stream only a short distance outside the continental shelf, is fundamentally due to their inability to survive, or reproduce in the low temperatures of the coast water. But their failure to appear there in greater numbers, sporadically or seasonably, as they do off the southern coast of New England, is evidence that the indraught of offshore water into the Gulf, is not from the Gulf Stream proper, but from the zone of mixed water along its inner edge (p. 239).

Aside from corroborating our earlier work, the plankton records for 1915 are chiefly valuable for the light they throw on the immigration of northern organisms into the Gulf of Maine, and on the seasonal changes in the relative faunal importance of the various boreal organisms there.

Previous to 1915, we had never found any unmistakable Arctic component in the plankton, for though three species common in Arctic waters, *Calanus hyperboreus*, *Clione limacina*, and *Eukrohnia hamata* have been taken in some numbers, the first two may be endemic (p. 302), while the last is as likely to have reached the Gulf from the mid-layers offshore, as from the north (1914a, 1915). And while a few Arctic organisms have been recorded in the past, *e. g.*, the medusa Ptychogena and the ctenophore Mertensia, (Agassiz, 1865) it is not possible to connect their occurrence with hydrography. Consequently the discovery of a plankton element of unmistakable northern

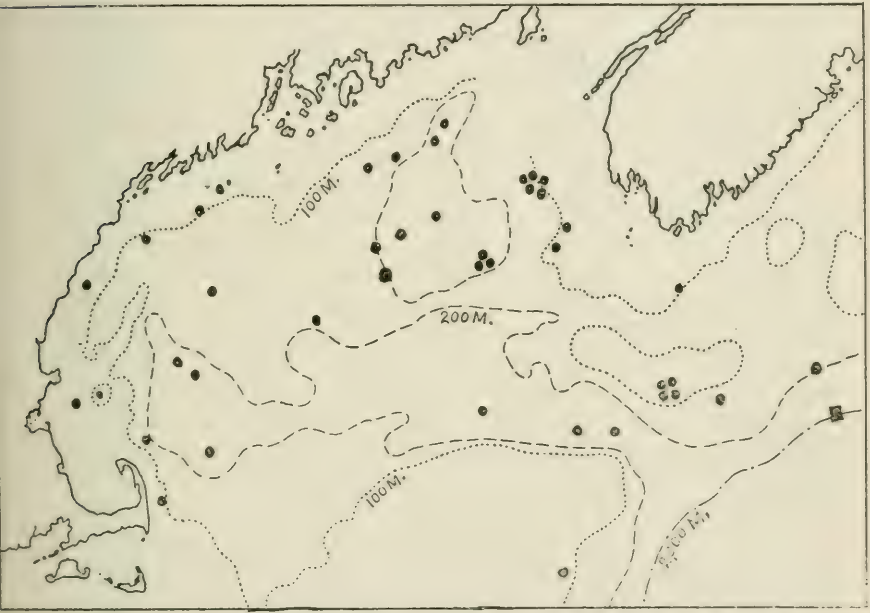

FIG. 80.— Localities (●) in the Gulf of Maine where tropical and subtropical plankton organism have been taken, 1912–1915.
■ = several records.

origin, *i. e.*, the pteropod *Limacina helicina*, the appendicularian *Oikopleura vanhöffeni*, and of Mertensia, associated with the Cabot Current water in the Gulf in May, 1915, marks a distinct advance in our knowledge. These as shown on the chart (Fig. 81) were all taken just where salinity (p. 224) and temperature (p. 215) gave clearest evidence of this northern water (Stations 10270, 10272), and each was represented by so many specimens, that their occurrence can not be looked on as accidental. The appearance of the Arctic Oikopleura in the Gulf is especially noteworthy, since it has not been recorded previously on this side of the Atlantic south of Baffins Bay, though known in European waters as far south as the Shetland Islands (Lohmann, 1896, 1910). Thanks to Lohmann's excellent descriptions and figures (1896, p. 72, taf. 14, fig. 6, 7, 10; 1910, p. 15, fig. 16, 17) it is easily recognized, its chief difference from the closely allied *O. labradorensis* being the presence of many small, dendritic,

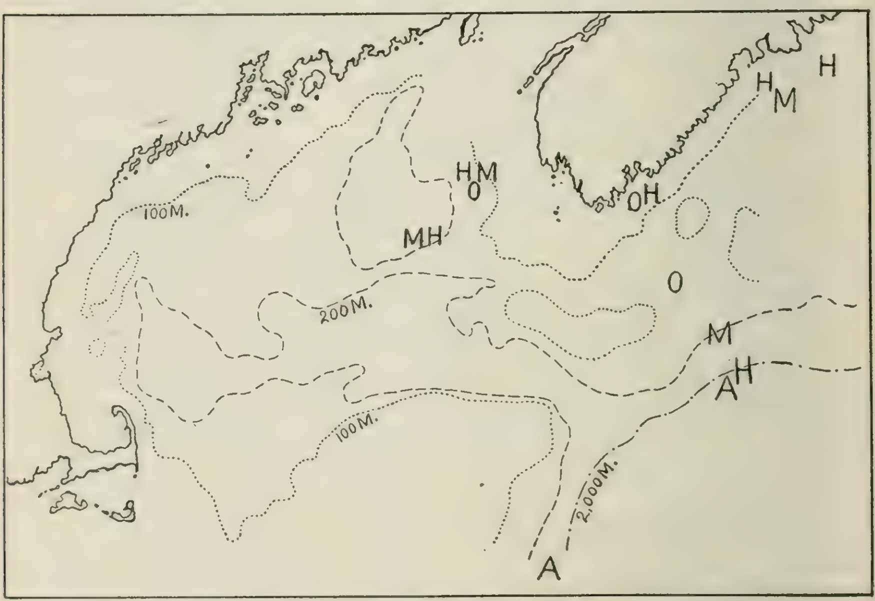

FIG. 81.— GRAMPUS records of Arctic plankton organisms in the Gulf of Maine, 1912–1915.

H, *Limacina helicina:* M, *Mertensia ovum:* O, *Oikopleura vanhöffeni.*

Diphyes arctica is given here also (A), though its geographic origin is doubtful (p. 306).

subchordal cells. Its very large size (rump-length upwards of 4 mm.) is likewise diagnostic, while the red margin of the tail makes it a conspicuous object in the water.

None of these Arctic forms were encountered in the Gulf on our later cruises (June–October), their absence coinciding with the shrinkage of the Cabot Current (p. 242). But they were all present in June across the whole breadth of the shelf off Shelburne (Mertensia, Station 10291, 10294: *Oikopleura vanhöffeni*, Station 10291, 10293: *Limacina helicina*, Station 10295).

Our records indicate a further shrinkage in the southward and westward extension of the Arctic faunal community, as the summer advances, for it hardly extended beyond Halifax in August, 1914 (*Limacina helicina*, Station 10236, 10237; Mertensia, Station 10236).

Previous records of Arctic organisms in the Gulf of Maine are too scanty to show whether there is an annual spring invasion from the Cabot Current, as was certainly the case in 1915. But judging from the hydrography of the Gulf in general and of the northern and southern currents in particular, this is probable. The mere fact that neither Mertensia, the Arctic Oikopleura nor *Limacina helicina* were found in the Gulf in the summers of 1912, 1913, or 1914, argues nothing against this view, for they were equally wanting there in the summer of 1915. And experience shows that Mertensia (A. Agassiz, 1865), apparently also Limacina, is so delicate, and so rapidly killed by unduly high temperature, that its absence at any particular time has no necessary bearing on conditions one or two months previous. The Grampus records do not indicate any greater invasion of Arctic animals in 1912, 1913, or 1914, than in 1915, though the occasional appearance of Mertensia in abundance at Eastport in September (A. Agassiz, 1865, p. 29; Fewkes, 1888), and of Mertensia and Ptychogena in Massachusetts Bay in the autumn (A. Agassiz, 1865) suggests that they are occasionally more important in the economy of the Gulf than we have found them in recent years. Unfortunately we have no records of the Gulf plankton for the year 1884, interesting because of its low temperature (1915, p. 243).

The Grampus hauls of 1915 demonstrate that, as a general rule, the plankton at any given part of the Gulf changes very little in its composition during the summer. Perhaps the most striking example of the permanence of the general plankton type is afforded by German Bank, where a swarm of Pleurobrachia (p. 306) prevailed, almost to the exclusion of other forms, from May (Station 10271) to September (Station 10290, 10311); and where we have usually found Pleurobrachia abundant, though less dominant, in other years (1914a, 1915).

Similarly the much more diversified plankton of the Eastern Basin, varied little throughout the season, September, like May hauls, consisting chiefly of *Calanus finmarchicus*, and Pseudocalanus, with smaller numbers of such other boreal forms, as *Euchaeta norvegica* (p. 292), Sagittae, Euthemisto (p. 286), *Limacina balea* (p. 298), and Thysanoessa (p. 283). In the northeast corner of the Gulf the deep hauls yielded large numbers of *Meganyctiphanes norvegica* and *Euchaeta norvegica*, besides the typical Calanus plankton, both in May (Station 10273) and in June (Station 10283), while they were similarly abundant at this locality, below about 100 meters, in the summers of 1914 (Station 10246), and 1913, 1915 (Station 10097).

In the coastal belt from Cape Elizabeth to Mount Desert a decided increase took place during the summer (p. 314) in the amount of macroplankton present in the water, coincident with the shrinkage of the diatom swarm (p. 325). But the only important change in its composition, either off Mt. Desert (Stations 10275, 10285, 10329) or off Cape Elizabeth (Stations 10277, 10326), was that the nearly pure copepod plankton (chiefly Calanus) of May grew more varied, as the season advanced, by an increase in the relative abundance of such other typical boreal organisms as Euthemisto, *Sagitta elegans*, Meganyctiphanes, Thysanoessa, and *Limacina balea.*

A similar change took place both in the Western Basin (Stations 10267, 10299, 10307) and off Cape Ann, (Stations 10266, 10306, 10324), where great numbers of young Euthemisto appeared in the August–October hauls, besides a general increase in the other boreal forms typical of the general Gulf of Maine plankton (p. 243, 1915); and off Cape Cod, where swarms of Pleurobrachia appeared in October (Station 10323).

Station 10282 in the Bay of Fundy deserves brief mention, as no deep tows had previously been made in this region. The bulk of the hauls consisted of *Calanus finmarchicus* and small copepods, with occasional Clione, Euthemisto, *Sagitta elegans*, *i. e.*, they were of the usual Gulf of Maine type. But there were no Euchaeta, even in the haul from 175 meters.

Our records all go to show that regional, like seasonal differences in the plankton are slight in the Gulf. In fact the only important variations from the general type so far detected are a prevalence of neritic organisms, larvae etc., close to land; a greater proportional importance of animals of oceanic, and of northern origin in the eastern part of the Gulf (the immigrants from northern and from tropical waters discussed above, p. 246, 247) and the local swarming of animals, such as Pleurobrachia, which occur in small numbers elsewhere in the Gulf.

Oceanic and neritic Plankton in the Gulf of Maine.— The influence of the coast line on the plankton is now generally recognized; and the distinction between oceanic and neritic forms has often been drawn; the latter term embracing such organisms as are actually dependent upon the bottom in shallow water, in order to pass through some stages in development (Gran, 1915). This, of course, includes forms which pass the winter, or other unfavorable seasons, on the bottom as resting spores (*e. g.*, some diatoms); the eggs and larvae of bottom-dwelling Metazoa, and Metazoa which pass through a fixed stage in development, as so many hydroid medusae do. Considering the length and complexity of the shore-line of the Gulf; its rich littoral fauna, and the very considerable amount of land water which the rivers pour into it, we might naturally expect its endemic plankton to be largely recruited from the shallow coastal zone; and it is a commonplace, for the Gulf as truly as for the eastern side of the Atlantic, that various neritic organisms often swarm near shore, particularly in the estuaries, bays, and sounds and among the numerous rocky islands.

But in our four years experience we have never found them playing a rôle of any importance in the plankton of the central parts of the Gulf; and how rare they are, except within a trivial distance of the land, may be illustrated by the following facts of distribution. We have always found neritic diatoms, of which *Thalassiosira gravida*, *Th. nordenskioldi*, *Chaetoceras debile*, *Asterionella japponica*, and Guinardia, may serve as examples, (Ostenfeld, 1913; Gran, 1902), practically limited to a narrow coastal zone hardly over fifteen miles broad, including the sounds and bays among the islands; and to the shallow waters over Georges Bank (p. 321).

A similar state of affairs obtains for the neritic Metazoa. For instance, one of the most striking features of our hauls has been the rarity of the neritic Scyphomedusae, Aurelia and Cyanea, in the center of the Gulf, contrasted with their abundance along shore (1914a, p. 124, pl. 6. Aurelia, in fact, is seldom seen more than a few miles from land; and though Cyanea is not so closely restricted, it is abundant only along the coastal zone, and in the shallow waters of Nantucket Shoals and Georges Bank.

Perhaps the most important index to land water among the Hydromedusae, because of its size, abundance, and the fact that its fixed stage is well known (A. Agassiz, 1865), is *Melicertum campanula*; a jelly-fish swarming in the bays and among the islands of the Gulf (1914a, p. 25). But in all our cruises we have only once found Melicertum more than fifteen miles from land, a single specimen in the Western Basin, in August, 1913 (Station 10088). The medusae of the genus Sarsia are similarly restricted to the coast, for while they are liberated in great numbers along shore, and on the shallow coastal banks in spring (1914b, p. 407) we have never taken any in the central parts of the Gulf, and only rarely more than a few miles from land.

Still another example of neritic occurrence is afforded by the hydroid colonies which float, in swarms, over Nantucket Shoals (1915, p. 306) and Georges Bank (1914b, p. 414) early in the season, but which are so closely confined to the regions where they are torn from the bottom, that we have never found them nor their free medusae, anywhere in the deep central parts of the Gulf.

There are, it is true, several medusae, with fixed stage, which do occur more or less generally over the Gulf, for example Staurophora and to a less degree *Phialidium languidum* (1914a). But this is to be explained on the assumption that their fixed stage is not confined to shallow water. They are thus in the same class as Sebastes, among fishes (p. 280) so far as their dispersal over the Gulf is concerned.

Among the Crustacea excellent examples of the neritic habit are afforded by the pelagic larval stages of the various littoral decapods, particularly the crabs; and by the phyllopod genus Evadne (Gran, 1902).

Young crabs (Cancer sp.) are produced in large numbers all along the coast line, in July; and they are usually represented in the summer hauls near land, occasionally in swarms, for example, in Ipswich Bay, and off Rye, on July 23, 1915.′ But they have never been detected in our offshore hauls; and what is true of crab larvae holds equally for the other metozoan larvae which are so important a part of the plankton near shore. Evadne, long recognized as one of the most important index forms of the plankton (Gran, 1902; Apstein, 1910; Herdman and Riddel, 1911), occurs regularly in summer in the Bay of Fundy off the mouth of the St. Croix river (Willey, 1913), as well as off the Nova Scotian coast (Wright, 1907). But in 1915 we detected it at only nine Stations (10287, 10302, 10303, 10313, 10317, 10318, 10319 and in Shelburne Harbor), all within ten miles of land, and most of them much nearer; and although Evadne is a seasonal organism, its absence in the more oceanic parts of the Gulf can hardly be laid to the season because the offshore work continued from spring to autumn.

It is less easy to divide the copepods than other Crustacea into the neritic and oceanic categories because they are pelagic at all stages. Hence, (barring brackish water species) what is neritic in one sea, may prove to be oceanic in another. Nevertheless, since they constitute the bulk of the plankton of the Gulf of Maine, I may point out that species which are generally classed as neritic in the North Sea region play only a very subordinate rôle, if they occur at all, in the central part of the Gulf, our lists containing only five which are so classed by Farran (1910, 1911), Scott (1911), Herdman and Ridell (1911) and Gough (1905, 1907), viz Acartia, *Tortanus discaudatus*, *Centropages hamatus*, Eurytemora, and Temora. We have only one or two records for each of the first four outside the outer islands; none from offshore parts of the Gulf (1914a, 1915). The fifth, *Temora longicornis,* is apparently less closely confined to coastal waters in the western than in the eastern side of the Atlantic for in the summer of 1913 (1915) it was generally distributed over the Gulf, though there was no corresponding expansion of other neritic organisms. But as a rule, it is common only locally near land, and over Nantucket Shoals and Georges Bank, a distribution roughly paralleling that of Cyanea (p. 251).

Finally it is justifiable to refer such fish eggs as are spawned near land, to the neritic category. Examples of this sort, in the Gulf of Maine, are afforded by the Cod and Haddock, which are very rarely encountered outside the 100 meter curve, though spawned all around the periphery of the Gulf within that depth zone (p. 251).

These facts show that neritic organisms, strictly speaking, are closely confined to a narrow coastal zone in the Gulf of Maine in summer, and to the shallow banks that form its southern rim; none of them have ever been found in any numbers in the deep central parts of the Gulf; and most of them are unknown there. This is as good evidence as is salinity (p. 241) that at that season, *i. e.*, after the spring freshets are passed, the land water hugs the coast. In early spring, when the rivers are in flood, conditions may be different; but the water is so cold at that time, that the vernal wave of reproduction has hardly begun on the part of the littoral fauna.

The typical, endemic plankton of the center of the Gulf, is composed of species independent of the bottom, *i. e.*, "haliplankton"; most of them known to be oceanic as opposed to neritic in European waters. Thus the diatom plankton which we encountered offshore in May (p. 324) consisted chiefly of *Chaetoceras densum* and *Rhizosolenia semispina;* both so characterized by European students (Gran, 1905;

Ostenfeld, 1913; Herdman and Ridell, 1911). And the Ceratium plankton, which occupies the Gulf as a whole throughout the summer is composed of species (*Ceratium tripos*, and *C. longipes* var. *atlantica*) which are usually regarded as oceanic in the North Sea region (Paulsen, 1908; Jorgensen, 1911), and in the Norwegian Sea (Gran, 1902). The same is true of most of the Metoza characteristic of the Gulf, for example, the copepods *Calanus finmarchicus* (Damas, 1905; Gran, 1902; Farran, 1911; Herdman and Ridell, 1911), Pseudocalanus, Euchaeta and Metridia, (Farran, 1910; Herdman and Ridell, 1911): the amphipods *Euthemisto bispinosa* and *E. compressa* (Tesch., 1911; Sars, 1890–1895); the pteropod *Limacina balea* (Paulsen, 1910 "*Limacina retroversa*"): and the euphausiid *Thysanoessa inermis* (Kramp, 1913; Tattersall, 1911). Two other faunistically important members of the plankton, *Sagitta elegans* and *Meganyctiphanes norvegica* are intermediate between oceanic and neritic in the North Sea region (Apstein, 1911; Kramp, 1913). In the Gulf, however, they cover practically the same range as the more typically oceanic forms just mentioned. Furthermore, not only do these oceanic animals occur generally over the central part of the Gulf, but they constitute the bulk of the plankton even close to the land, except for a brief period in early spring, when their place is taken by the vernal diatom wave (1914b).

On the other side of the Atlantic most of these species, most characteristic of the Gulf plankton are oceanic, not only as opposed to neritic, but as inhabitants of the neighboring parts of the Atlantic Basin. This is also the case right across the North Atlantic, from the Norwegian Sea and Iceland on the east, to Newfoundland and Nova Scotia on the west (Herdman and Scott, 1908; Murray and Hjort, 1912). But thence southward, the band of cool water along our coast is a sort of *cul-de-sac* for them, the Gulf Stream limiting them on the one side, as the coast line does on the other; and most of them probably are not endemic south of New York, though they may appear there as immigrants from the northeast, in the southwest current which prevails along that part of the coast (1915).

Fish Eggs and young Fish.— The study of the fish eggs is much faciliated by the fact that comparatively few species producing pelagic eggs are common in the Gulf of Maine. Furthermore, the eggs of most of the economically important fishes, *e. g.*, Cod, Haddock, Silver Hake, Hake, Mackerel, and several of the flounders, are easily recognized; and as it happens, these species have usually composed the bulk of the fish eggs collected.

The stations, near land, or in shallow water, *e. g.*, on Georges Bank, have usually yielded fish eggs, sometimes in large numbers. But we have found very few in the deep offshore parts of the Gulf, except off the slope of German Bank (Station 10270) and in the Eastern Basin (Station 10249 in 1914, 10304, in 1915). This was especially the case in May and June, when no fish eggs of any species were taken in the central parts of the Gulf, or on the outer part of the shelf off Nova Scotia; and though the barren area is reduced in midsummer, by the occurrence of eggs in the Western and Eastern Basins, we have never found a single fish egg in the central or southern deeps of the Gulf, or in the Eastern Channel (Stations 10225, 10227, 10255 in 1914; Stations 10268, 10269, 10298, 10299, 10308, 10309 in 1915); and pelagic fish eggs are usually so rare anywhere in the Gulf over water deeper than 100 meters, even, including the narrow trough north of Cape Ann (Stations 10278, 10325), that very few can be spawned anywhere in the Gulf except along the shallow coastal zone. But the shallow waters of Georges Bank are certainly an important, perhaps our most important, spawning ground for Haddock in spring (1914b); and this is probably true for Brown's Bank also, although we have found very few eggs there in summer.

So much discussion has centered around the quantitative occurrence of pelagic fish eggs, as the basis for a census of the fish population of the North Sea, (Johnstone, 1908) that particular attention was paid to this subject during the cruises of 1914 and 1915.

In 1914 the results of the quantitative hauls were as follows:—

Station	Eggs per square meter of sea area	Station	Eggs per square meter of sea area
10213	150	10227	0
10214	0	10229	0
10215	140	10230	80
10216	0	10232	190
10218	0	10237	0
10219	0	10243	0
10223	30	10244	0
10224	0	10245	0
10225	0	10246	0
10226	10	10247	60

This agrees, essentially, with the horizontal hauls, it being only at Stations 10213, 10215, 10223, 10230, 10232, and 10247, that eggs were taken in any numbers in any of the nets.[1]

The results of the two classes of hauls, quantitative and horizontal, for 1915, were as follows:—

Egg catches, at stations where both types of hauls were made.

Station	Eggs in horizontal hauls	Eggs in quantitative hauls	Station	Eggs in horizontal hauls	Eggs in quantitative hauls
10266	12	1	10313	18	0
10270	300	14	10316	15	0
10271	0	1	10317	f	0
10275	200	5	10318	55	2
10277	19	4	10319	f	0
10278	1	0	10320	3	0
10279	75	4	10321	20	1
10281	1	0	10323	11	3
10282	0	1	10327	1	0
10284	m	0	10328	25±	0
10286	0	1	10329	3	0
10287	300+	0	10331	200+	11
10290	15	0	10332	2	0
10291	50+	1	10333	0	2
10304	45	81	10336	9	0
10306	3	27	10337	f	19
10307	2	4	10338	f	2
10310	2	0			

f = 25 — 100 m = 100 +

This table shows that there is little correspondence between the two sets of hauls; thus in two instances the vertical net caught no eggs (Stations 10284, 10287) though the horizontal hauls yielded large numbers. And on the other hand, in two instances (Stations 10304, 10306) the catches of the vertical net were larger than those of the horizontal (surface) nets. Hence to plot the abundance of eggs in the Gulf from the quantitative hauls alone would give a very erroneous result. The truth of the matter appears to be that in our waters fish eggs are very streaky in occurrence; and as the surface net is usually towed for a mile, it is far more likely to encounter eggs, even in regions where they are abundant, than the vertical net. But it sometime chances that the vertical net hits, the surface net misses, a streak of eggs. In this respect, as in the irregular distribution of microplankton, (1914b), the Gulf of Maine resembles the Irish channel (Herdman, 1897, 1910); and it follows that a census of eggs in the Gulf would require a great number of vertical hauls, in proportion to the area covered.

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[1] In 1914 fish eggs were taken at the following Stations only:— 10213, 10215, 10220, 10223, 10224, 10226, 10230, 10232, 10236, 10247, 10248, 10249.

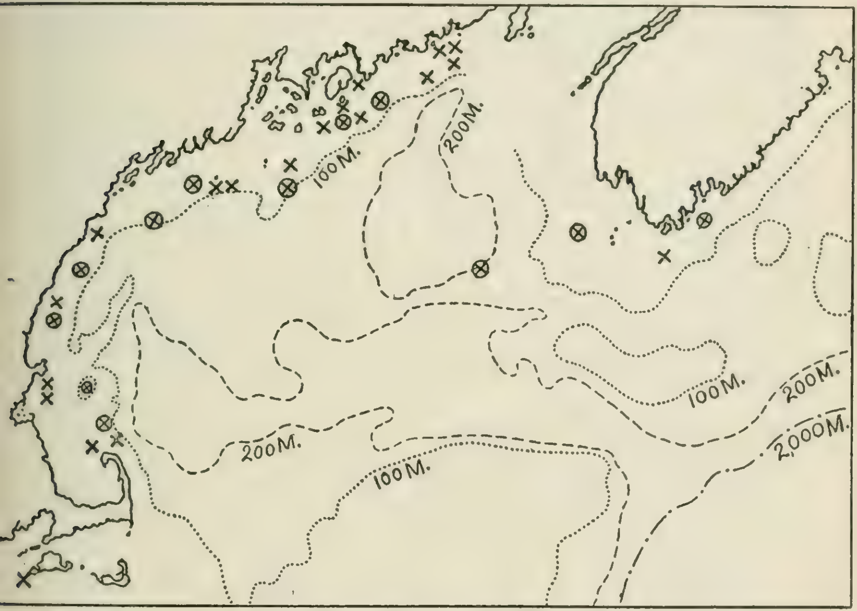

FIG. 82.— GRAMPUS records for Cod and Haddock eggs, 1912–1915. ⊗ May–June; X, July–October.

Cod and Haddock Eggs.— Eggs of Cod and Haddock, indistinguishable when newly spawned, were taken throughout the season from May to October, and there was no seasonal limitation of spawning to one, or other side of the Gulf. But as the chart (Fig. 82) shows, eggs in early stages were restricted to the zone between the coast and the 100 meter curve, except off German Bank (Station 10270); and even that locality was only fifteen miles distant from the 100 meter curve. This was the case in 1914 also; and as other fish eggs do occur in the catches made at the numerous stations in other parts of the Gulf, we can only conclude that in spring and summer, Cod and Haddock spawn only in this narrow coastal belt, just as the Cod do off the Norwegian coast (Hjort, 1914), with no spawning of any importance in the central basin of the Gulf; and our catches afford no evidence that the isolated peak of Cashe's Ledge is of any importance as a spawning ground in summer or spring, though it may so serve in winter. But Haddock are known to spawn on Georges Bank, in large numbers, in early spring (1914b, p. 415); though no Cod or Haddock eggs were taken there in summer.

The records of Cod-Haddock eggs for 1915 are given in the following table:—

1. Quantitative Hauls.

Station	Number eggs	Station	Number eggs
10266	1	10279	1
10270	14	10304	1
10271	1	10318	1
10277	1		

The other quantitative hauls (29 stations) yielded none.

2. Horizontal Hauls.

Station	Eggs in all hauls	Station	Eggs in all hauls
10266	10	10304	1
10270	m	10305	9
10277	9	10313	4
10279	f	10316	1
10280	f	10317	75+
10284	75	10318	12
10285	m	10319	21
10287	f	10320	1
10290	3	10321	1
10291	f	10323	6
10300	f	10327	1
10301	m	10328	20
10302	f	10329	2
10303	M	10330	4

Also at the following localities:— off Libbey Island; South West Harbor, Maine (many); off Petit Passage, N. S. (few).

The largest catches were off the coast of Maine, east of Penobscot Bay, and off German Bank. But no great stress can be laid on this, because the stations in the shallow water near land were not systematically located; other "rich" areas may well have been missed.

Our hauls throw very little light on the actual numbers of eggs present, there being no quantitative hauls at several of the stations *e. g.*, 10301, where the horizontal hauls were richest, and their catches as a whole being scanty, usually the minimum possible; (*i. e.*, one egg). But at least it is clear, that in late spring or summer we have never encountered anything comparable, in importance, to the spawning of Haddock in Massachusetts Bay, and along the shore from Cape Ann to Cape Elizabeth, in April and May, which was observed in 1913 by W. W. Welsh (1914b).

In Norwegian waters newly spawned Cod eggs are most plentiful over the fifty fathom contour (Hjort, 1914). But our results suggest that the distribution of spawning grounds in the Gulf is less dependent on depth, the richest hauls of eggs being at localities where the depths were, respectively, thirty meters (Winter Harbor), sixty meters (Station 10285); seventy-five meters, (off Libbey Island), and about 200 meters (Station 10270). But the stations were not close enough together, either in time or in space, to allow any precise mapping of spawning areas.

The great majority of Cod and Haddock eggs taken were either just laid, or at least so young that identification as one or the other species is impossible: the few identified specimens [1] are as follows:—

HADDOCK		COD	
Station	Eggs	Station	Eggs
10278	4	10280	1
10280	5	10291	6
10291	5	10305	1
Off Petit Passage,		10313	4
Nova Scotia	1	10317	2
		10329	1

Thus eggs which can certainly be identified as Haddock occurred only in May and June, while Cod occurred throughout the season; and this, of course agrees with the well-known fact that the spawning of Haddock in the Gulf is at its height in early spring, while Cod have long been known to spawn there throughout the year.

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[1] For details of pigment, separating Cod and Haddock before hatching, see Ehrenbaum, 1905–1909; Murray and Hjort, 1912; Hjort, 1914; Schmidt, 1905, 1906.

It may, of course, be merely a coincidence that out of the hundreds of eggs examined, so few have reached an advanced stage in development. But in view of the general movement of water along the shore of the Gulf from northeast to southwest, this fact is of considerable interest, for it suggests the possibility that eggs spawned, for instance, off Cape Ann, may hatch on Georges Bank. But much more extensive data is needed to show whether such a migration actually takes place.

Oceanographically, the restriction of newly spawned eggs to the coastal zone is interesting, like the similar restriction of the ranges of other neritic Metazoa (p. 251), as evidence of how slow the interchange of water between the central and peripheral parts of the Gulf is; and conversely, the large numbers of eggs encountered over the slope of the Eastern Basin in May (Station 10270), where neither depth of water, character of bottom, nor common report of fishermen suggests the presence of Cod or Haddock in numbers, may well have been carried there, from the neighboring slope of German Bank, which is a well-known fishing ground, by the Cabot Current.

Pollock Eggs.— The spawning of Pollock (*Pollachius virens*) has long been known to reach its height, on the west side of the Gulf, in late autumn and early winter. In 1915 Pollock eggs first appeared in the tow on September 29 (Station 10321), when one was taken; and occasional eggs of this species were taken on October 1st, 18th, and 26th, (Stations 10323, 10330, 10336, 10337); about 150, all in early stages in development on October 27th.

The fact that these records are all from Massachusetts Bay, and from Cape Cod, has no bearing on the distribution of Pollock eggs in the Gulf, because no stations were located in its northern or eastern part after October 15th, *i. e.*, after Pollock spawning was well started.

Silver Hake Eggs.— In 1915 the eggs of the Silver Hake (*Merluccius bilinearis*) were found sparingly from June (Station 10284) until the middle of October (Station 10331), at the localities shown on the accompanying chart (Fig. 83). On four occasions they occurred in large numbers, *i. e.*, off Race Point, Cape Cod, July 7th (Station 10300); off Duck Island, Maine, July 19th (Station 10302); off Rye, N. H., July 23rd., and near Monhegan Island, Me., August 4th (Station 10303). Thus the Silver Hake spawns all along the shore of the Gulf and off southeastern Nova Scotia, chiefly between the land

and 50 fathom curve, just as Cod and Haddock do, though the eggs appear far less regularly than those of Cod or Haddock. So far as our scanty records go, Silver Hake do not begin to spawn in the Gulf until June, for none of their eggs were found at any of our stations in May; spawning is at its height in July and August (Stations 10300–10305); and continues, though greatly diminished, through September and the first half of October, as illustrated in the table, p. 262.

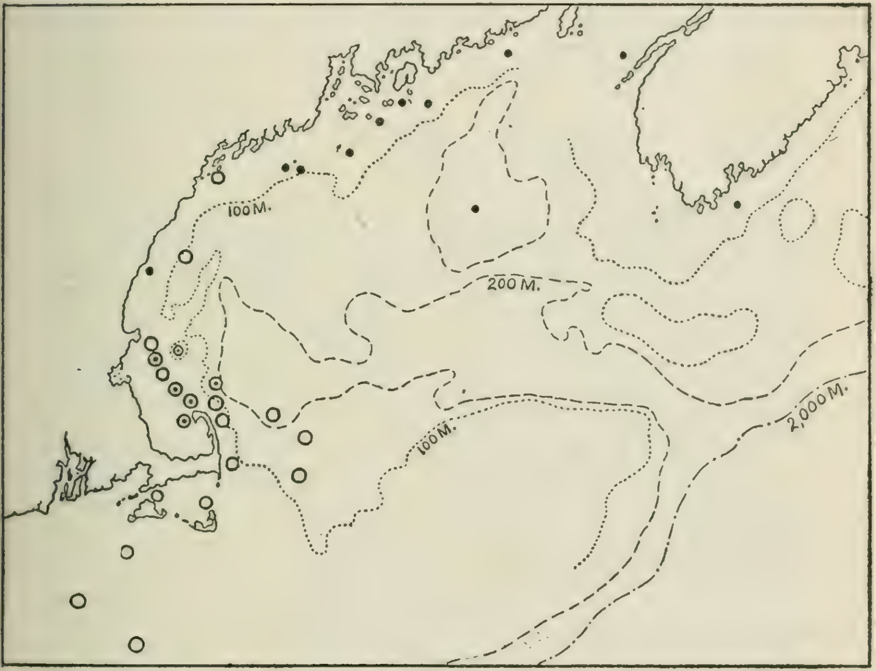

Fig. 83.— **Grampus records for young fry and eggs of the Silver Hake, 1912–1915:** ●, **eggs;** ○, **fry;** ⦿, **eggs and fry.**

Unfortunately no quantitative hauls were made at the Stations (10300, 10302, 10303, 10305, off Rye, or off Wooden Ball Island), where Silver Hake eggs were most numerous, so no estimate can be made of the actual numbers present there. At the only other Station (10304), where the total catch was more than 100, the quantitative haul yielded thirty-eight eggs, *i. e.*, 190 per square meter. In only two other quantitative hauls did Silver Hake eggs occur (Station

Date	Station	Eggs in all hauls	Date	Station	Eggs in all hauls
June 10	Off Petit Passage	f	Aug. 10	Off Libbey Is.	1
" 11	10284	f	" 18	10305	*m*
" 14	10287	f	" 31	10306	3
July 7	10300	*m*	Sept. 6	10313	10
" 19	10302	*m*	" 18	10318	8
" 23	Off Rye, N. H.	*m*	" 29	10320	2
Aug. 4	10303	*m*	" 29	10321	15
" 6	10304	m	Oct. 1	10322	14
" 6	Off Wooden Ball Is.	m	" 1	10323	2
			" 22	10331	f

f = 25–50; m = 100 +; *m* = 1000 +.

10306, three eggs: Station 10323, one egg), although hauls of this type were made at seven more stations where they did occur in the surface hauls; and this agrees with the general experience that vertical hauls with small nets are of little value where the number of fish eggs present is less than fifty or so per square meter (p. 256).

Our records are too scanty to show whether spawning is fairly uniform all along the coastal zone, or is limited to particular grounds, as is the case with Cod off Norway (Hjort, 1914).

Squirrel Hake Eggs.— Very little is known about the eggs, or young, of species of Urophycis in the eastern Atlantic (Ehrenbaum, 1905–1909, p. 275); and though it is a far more important genus economically in American than in European waters, its pelagic eggs have only once been recognized off our coast, *i. e.* during the GRAMPUS cruise of 1912 (1914a, p. 100). The identification, in that case, rested on comparison with ripe eggs taken from Squirrel Hakes (*Urophycis chus*) caught near by, and fertilized on board ship. But only newly spawned eggs were seen, hence the recent success of the Gloucester Hatchery of the Bureau of Fisheries in not only artificially fertilizing, but hatching, the eggs of this species, is very timely.

Squirrel Hake eggs, in different stages received from the hatchery, may be described briefly as follows: — they are small, ranging in diameter from .7 to .75 mm. Shortly after fertilization there are usually many small oil-globules; but these coalesce, until at 26 hours, (at a temperature of 15.5° C.) there is usually one large oil-globule, about .15–.17 mm. in diameter, with two or three tiny ones close beside it: occasionally, however, there is only one oil-globule at this stage, of about .17 mm. No pigment is yet present. At 50 hours the character of the oil-globule is much the same, but the embryo is now of considerable size, and the pigment has appeared. One of the most characteristic features of this species is the presence of black chromatophores scattered over the yolk, present there even at this early stage. At about 74 hours, not only embryo and yolk, but oil-globule as well, is pigmented. At 98 hours, the oldest stage examined, the embryo is far advanced, its length almost equal to the diameter of the yolk. The embryonic pigment consists of few large chromatophores and similar ones are scattered over both oil and yolk. Even at this stage, there are usually, but not always, several tiny globules close to the chief one.

This species is easily distinguished, in late stages, from most other pelagic eggs so far identified from the Gulf of Maine, by small size, (.7–.75 mm.) in connection with the structure of the oil-globule, and particularly the pigmented yolk. But it may prove difficult to separate it from the Rockling (*Enchelyopus cimbrius*) which has an egg of about the same dimensions, and in which, likewise, there are several oil-globules, when newly spawned, one chief one of .14–.19 mm., pigmented, with several small ones, (Ehrenbaum, 1905–1909, p. 281, fig. C). However, older Rockling eggs from the North Sea have no pigment on the yolk, hence they could not be confused with Squirrel Hake; and though the yolk is sometimes pigmented in Rockling eggs in the Baltic, this does not seem to be a characteristic feature, but only an occasional manifestation of very dense pigmentation (Ehrenbaum, 1905–1909, p. 281). If the eggs which Agassiz and Whitman (1885) provisionally referred to the rockling, [= *Motella argentea*], really belong there, the American Rockling, like the Baltic, has a pigmented yolk, hence it would be difficult to distinguish these from the eggs of the Squirrel Hake. But they say that "it is by no means certain that the species has been correctly identified" (Agassiz and Whitman, 1885, p. 391). Silver Hake eggs in early stages might also be confused with eggs of the Butter fish, (*Poronotus triacanthus*), which are of about the same size and often have two oil-globules when newly spawned. But there is no pigment on the yolk or oil-globule in late stages in eggs of this species.

Eggs indistinguishable from the 50–90 hour eggs of the Squirrel Hake, described above, first appeared on June 10 in tows off Petit Passage and were taken occasionally thereafter until September 20th (Stations 10300, 10301, 10303, 10304, 10305, 10317, 10318, 10319, off Wooden Ball Island, August 6; off Libbey Island, August 10; and they also occurred off Shelburne in August, 1914 (Stations 10230, 10232). They occurred only twice in the quantitative hauls in 1914: three eggs at Station 10304, one at Station 10318.

Mackerel Eggs.— The Mackerel is commercially so important in the Gulf of Maine, and so little is known of its spawning habits, or migrations, that any records of its eggs are worth noting (Fig. 84).

Mackerel eggs were taken, irregularly, in May, June, July, and August, as shown in the following table, p. 265.

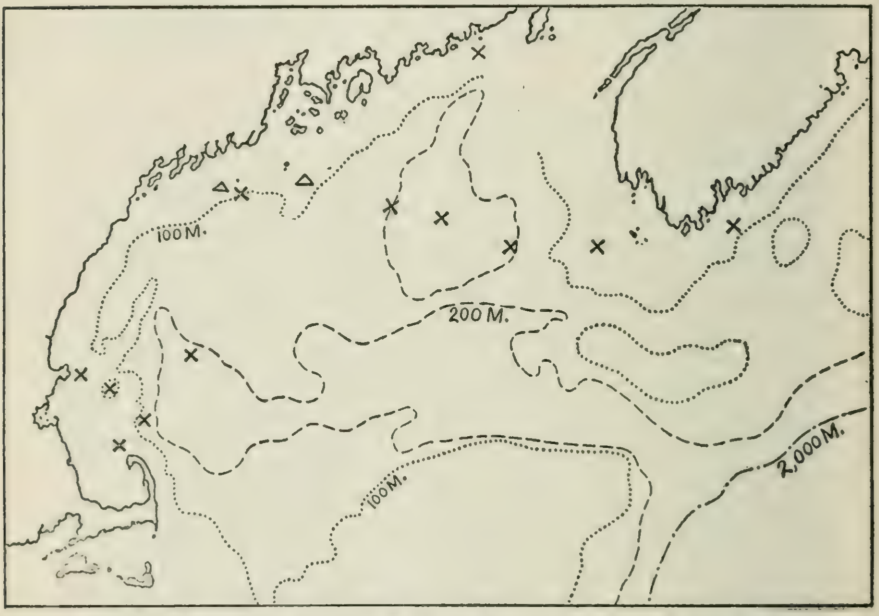

FIG. 84. Mackerel eggs, in 1915. X, records of occurrence; Δ, 50 or more in all hauls.

The quantitative hauls yielded only one egg, at Station 10291, singularly enough none, at the Station 10287 where Mackerel eggs were most numerous on the surface. At Station 10303 no quantitative haul was made.

These few records show that Mackerel spawn irregularly over the northern half of the Gulf throughout the summer. So far as they go, they suggest the region off the outer islands from Cape Elizabeth to Mt. Desert Rock, as the main spawning ground in the Gulf. But

Date	Station	Eggs in all hauls	Date	Station	Eggs in all hauls
May 6	10270	f	Aug. 7	10304	2
“ 26	10279	30+	“ 10	Off Libbey Is.	10
June 14	10287	200+	“ 11	“ “	20
“ 19	10290	6	“ 24	6 miles off Cape Ann	1
“ 23	10291	25+	“ 31	10306	3
July 7	10300	f	“ “	10307	1
Aug. 4	10303	m	Sept. 16	10318	1
“ 6	21 miles off Mt. Desert Rock	2			

spawning is not limited to the coastal banks, as in the case of Cod and Haddock, taking place over the basins as well; and as most of the eggs taken were newly spawned there can be no question of their having drifted from elsewhere.

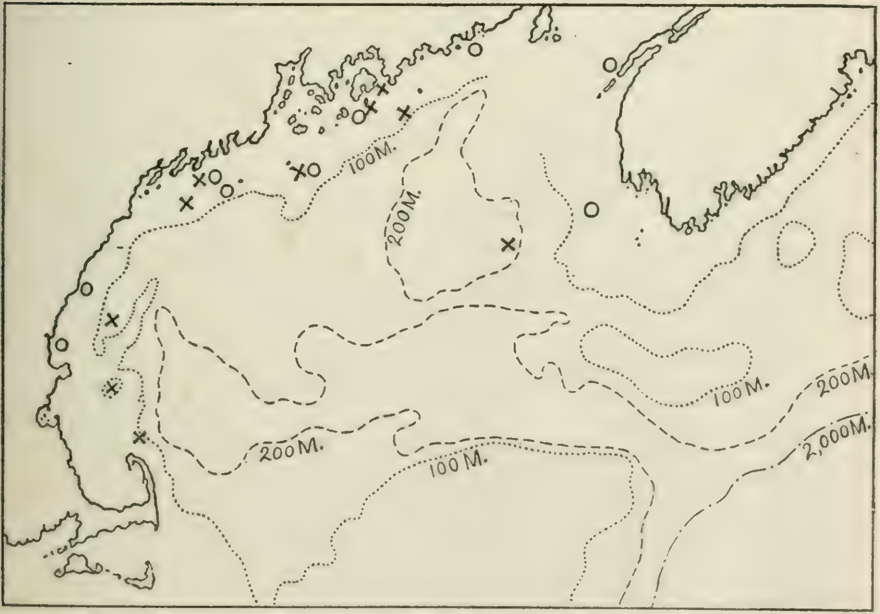

FIG. 85. GRAMPUS records for the eggs of the Sand Dab **X**, and of the Rusty Flounder **O**, in 1915.

The catches of Mackerel eggs are so small as to afford no basis for a claim that the Gulf is an important spawning area for this fish. But this may be purely accidental; Stations located a little differently in season or locality, might have yielded very different results. And caution in drawing any conclusions is especially needed in the case of a fish as erratic in its movements as the Mackerel.

Flounder Eggs.— Eggs of three of the several species of Flounders (Pleuronectidae) common in the Gulf of Maine have been detected in our hauls (Fig. 85).

The unmistakable eggs of the Sand Dab (*Hippoglossoides platessoides*) were only once taken in any numbers. The 1915 records are limited to May and June; and none were taken in July and August, 1914.

Date	Station	Eggs in all hauls	Date	Station	Eggs in all hauls
May 4	10266	4		10279	1
" 6	10270	1	May 31	10280	13
" 11	10275	204	June 2	Winter Harbor	25+
" 13	10277	13	" 11	10284	1
" 14	10278	1	" 14	10285	2
			" 14	10287	1

Apparently the spawning of this species is at its height in late spring; and as most of the shallow water stations were occupied in late summer and autumn, our records throw very little light on spawning areas, etc. Sand Dab eggs occurred in only two of the quantitative hauls, Stations 10275 and 10277, with four and three eggs respectively, *i. e.*, twenty and fifteen per square meter.

Eggs of the common Rusty Flounder (*Limanda ferruginea*)[1] occurred irregularly, May to the middle of September, but were lacking in the hauls in the latter half of that month and in October, table, p. 267.

None were taken in the quantitative hauls; but the quantitative net was not used in the coastal belt between Cape Ann and Cape Elizabeth at the time Rusty Flounder eggs were abundant there. The records for the Rusty Flounder are even more strictly limited to water shallower than 100 meters, than those for Cod and Haddock (p. 257).

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[1] The only Gulf of Maine species with which newly spawned eggs of the Rusty Flounder are likely to be confused is the Cunner (*Tautogolabrus adspersus*); and the two can usually be distinguished by size, the former averaging .9 mm., the latter .75–.85 mm. in diameter.

Date	Station	Eggs in all hauls	Date	Station	Eggs in all hauls
May 26	10279	f	July 15	10301	f
" 31	10280	f	" 19	10302	f
June 10	Off Petit Passage	f	" 23	Ipswich Bay	m
" 14	10285	f	" 23	Off Rye	m
" 14	10287	f	Aug. 4	10303	2
" 19	10290	4	Sept. 11	10316	1

We did not make enough hauls near shore in the early part of the season to develop the precise spawning grounds. So far as the records go, they suggest that spawning is at its height in July, but no general conclusions are warranted.

The eggs of the "witch" (*Glyptocephalus cynoglossus*) were detected twice only, Station 10279, May 26th, twenty specimens; Station 10287, June 14th, one egg.

Cunner Eggs.— Eggs of the Cunner (*Tautogolabrus adspersus*) were taken at seven localities, always close to land (Stations 10300, 10301, 10313, 10323, off Wooden Ball Island; off Petit Passage, Nova Scotia, and in Shelburne Harbor). The absence of its eggs at the offshore stations was to be expected, from its general distribution.

Menhaden Eggs.— The eggs of the Menhaden (*Brevoortia tyrannus*)[1] resemble those of the Pilchard (*Clupea pilchardus*) (Ehrenbaum 1905–1909, p. 374, Fig. 142) but are easily distinguished from all Gulf of Maine species, being characterized by large size (1.5–1.8 mm.); broad perivitelline space; small oil-globule (.15–.17 mm.), and very long embryo. Although the Menhaden appears in the Gulf of Maine in large numbers in summer, we have never found its eggs there. But they appeared in considerable numbers in the tows south of Marthas Vineyard (Station 10331) and in Nantucket Sound (Station 10335) in October.

Undetermined Eggs.— Among the eggs which I have not been able to identify, are a considerable number, about .85–.9 mm. in diameter, with small oil-globule (.12–.14 mm. in diameter), which much resemble eggs of the Summer Flounder (*Paralichthys dentatus*) studied by Mr. Radcliffe at Woods Hole. But since the Summer Flounder is rare north of Cape Cod, their identity is doubtful. Newly spawned eggs of this type occurred at Stations 10275, 10291, 10300, and 10316.

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[1] Identified by Mr. Lewis Radcliffe, U. S. Bureau of Fisheries.

Young Fishes taken in the Tow-nets.— Identified by Mr. W. W. Welsh.

ANGUILLIDAE.

Anguilla rostrata (LeSueur).

Yarmouth Harbor,	May 9, 1915	1 specimen	56 mm.
Winter Harbor	June 2, 1915	1 “	68 mm.

Leptocephalus sp.

1914.

Station 10218	60–0 meters	1 specimen	37 mm.

CLUPEIDAE.

Clupea harengus Linné.

1915.

Station 10273	0 meters	1 specimen	50 mm.
“ 10275	0 “	3 “	39–41 mm.
“ 10311	50–0 “	29 “	12–15 mm.
“ 10328	40–0 “	1 “	21 mm.
“ 10329	0 “	1 “	24 mm.
“ 10329	40–0 “	14 “	20–29 mm.
“ 10330	25–0 “	27 “	8–13 mm.
“ 10337	70–0 “	13 “	13–17 mm.
“ 10338	60–0 “	88 “	9–15 mm.

Clupea harengus Linné?

1915.

Station 10332	45–0 meters	108 specimens	14–19 mm.
“ 10333	20–0 “	13 “	13–17 mm.

Pomolobus pseudoharengus (Wilson).

1915.

Boothbay, Maine	July 21	495 specimens	25–48 mm.
“ “	August 3	160 “	23–53 mm.
“ “	“ 22	117 “	39–65 mm.

Brevoortia tyrannus (Latrobe).

1915.

Station 10335	8–0 meters	9 specimens	7.5–15 mm.

ALEPOCEPHALIDAE.

Alepocephalus sp. ?.

1915.

Station 10294	0 meters	3 specimens	21 mm.

MYCTOPHIDAE.

1914.

Myctophum sp.?

Station 10218	300–0 meters	1 specimen	15 mm.

Myctophum glaciale (Reinhardt).

1915.

Station 10295	500–0 meters	2 specimens	16 mm.

Myctophum species ? Larvae.

1914.

Station 10260	140–0 meters	1 specimen	20 mm.

1915.

Station 10233	70–0 meters	5 specimens	9–12 mm.

MAUROLICIDAE.

Valenciennellus tripunctulatus (Esmark).

1915.

Station 10295	500–0 meters	1 specimen	30 mm.

Maurolicus sp.? Larvae.

1914.

Station 10218	60–0 meters	1 specimen	7.5 mm.
	300–0 "	2 specimens	13.5–7.5 mm.

Chauliodontidae.

Cyclothone signata Garman.

1915.

Station 10295	500–0 meters	1 specimen	21 mm.
" 10296	60–0 "	1 "	23 mm.

Gasterosteidae.

Gasterosteus bispinosus Walbaum.

1915.

Winter Harbor	June 2	0 meters	9 specimens	38–45 mm.
Kittery "	August 2	0 "	7 "	19–29 mm.
Station 10307		230–0 "	1 specimen	30 mm.

Gasterosteus aculeatus Linné.

1915.

Winter Harbor	June 2	0 meters	1 specimen	52 mm.
Kittery "	August 2	0 "	28 specimens	19–29 mm.
Station 10307		230–0 "	2 "	39–43 mm.

Apeltes quadraticus (Mitchill).

1915.

Yarmouth Harbor	May 9	0 meters	1 specimen	34 mm.

Syngnathidae.

Siphistoma fuscum (Storer).

1915

Winter Harbor	June 2	surface	2 specimens	170 & 155 mm.

AMMODYTIDAE.

Ammodytes americanus DeKay.

1914.

Station 10231	surface	1 specimen	63 mm.

1915.

Station 10283	surface	1 specimen	32 mm.

LABRIDAE.

Tautogolabrus adspersus (Walbaum).

1914.

Station 10256	130–0 meters	1 specimen	10 mm.

1915.

Off Rye, N. H.	July 23	10–0 meters	110 specimens	5.5–10 mm.
Station 10319		25–0 "	2 "	7 & 8 mm.
Provincetown Harbor	Oct. 1.		18 "	26–51 mm.

SCORPAENIDAE.

Sebastes marinus (Linné).

1914.

Station 10226	70–0 meters	6 specimens	8–13 mm.
" 10229	80–0 "	38 "	8–11 "
" 10230	40–0 "	42 "	9–12 "
" 10231	surface	43 "	8–12 "
" 10232	60–0 "	150 "	6–12 "
" 10232	100–0 "	2 "	10 & 11 "
" 10243	40–0 "	104 "	9–15 "
" 10245	surface	6 "	12–15 "
" 10245	100–0 "	1 specimen	7 "
" 10246	50–0 "	12 specimens	11–19 "
" 10246	150–0 "	3 "	14–22 "
" 10248	50–0 "	35 "	9–14 "
" 10249	50–0 "	15 "	9–18.5 "

1915.

Station 10280	15–0 meters	1 specimen	10 mm.
" 10286	70–0 "	2 specimens	7 & 8 "
" 10303	60–0 "	many	6.5–9.5 "
" 10304	0 "	2 specimens	9 & 11 "
" 10307	0 "	20 "	18–27 "
" 10307	230–0 "	24 "	12–27 "
" 10308	0 "	swarm	14–40 "
" 10309	100–0 "	1 specimen	18 "
" 10310	130–0 "	3 specimens	10–12 "
" 10311	50–0 "	4 "	12–15 "
Southwest Harbor, Sept. 14	surface	1 specimen	17 "

COTTIDAE.

Myoxocephalus sp.

1915.

Station 10290	40–0 meters	2 specimens	8.5 mm.
" 10300	59–0 "	3 "	8–11 mm.

Genus ?.

1915.

Station 10311	50–0 meters	2 specimens	9 & 11 mm.

AGONIDAE.

Aspidophoroides monopterygius (Bloch).

1915.

Station 10280	15–0 meters	18 specimens	25 mm.
" 10290	40–0 "	5 "	26–29 "

CYCLOPTERIDAE.

Cyclopterus lumpus Linné.

1914.

Station 10224	60–0 meters	4 specimens	6–10 mm.

1915.

Station 10273	0 meters	15 specimens	23 mm.
“ 10280	15–0 “	2 “	38 & 46 “
“ 10281	0 “	1 specimen	8 “
“ 10290	40–0 “	4 specimens	6 & 7 “

LIPARIDAE.

Neoliparis atlanticus (Jordan & Evermann).

Station 10311	50–0 meters	2 specimens	7 & 11 mm.

PHOLIDAE.

Pholis gunnellus (Linné).

1915.

Station 10275	0 meters	1 specimen	21 mm.
“ 10290	40–0 “	35 specimens	32–28 “
“ 10291	60–0 “	1 specimen	24 “

STICHAEIDAE.

Ulvaria subbifurcata (Storer).

1915.

Station 10281	0 meters	6 specimens	7–11 mm.
“ 10291	60–0 “	1 specimen	10 “
“ 10311	50–0 “	1 “	21 “
“ 10319	25–0 “	2 specimens	14 & 34 “
“ 10325	25–0 “	1 specimen	11 “

CRYPTACANTHODIDAE.

Cryptacanthodes maculatus Storer.

1915.

Station 10273	surface	1 specimen	40 mm.

FIERASFERIDAE.

Fierasfer sp. Larvae.

Station 10260	140–0 meters	1 specimen	60 mm.

MERLUCCIIDAE.

Merluccius bilinearis (Mitchill).

1913.

(See Bigelow, 1915, for location of stations).

10 miles S. S. E. of Gloucester	July 7	16 specimens	5–8 mm.
Station 10057		95 “	3–13 “
“ 10058		1 specimen	7 “
41° 39′ N.; 69° 15′ W.;	July 8	20 specimens	6–11 mm.
Station 10063		33 “	7–16 “
“ 10070		2 “	7–9 “
“ 10082		108 “	6–14.5 “
Vineyard Sound	Aug. 3	29 “	2.5–6 “
Off Cape Cod	“ 4	38 “	2.5–6 “
Station 10086		120 “	3–6.5 “
“ 10087		21 “	4–15 “
“ 10104		37 “	4–9.5 “

1914.

Station 10256	130–0 meters	1 specimen	7.5 mm.
“ 10258	25–0 “	966 specimens	4–12 “
“ 10259	50–0 “	4 “	11–24 “

1915.

Station 10300	59–0 meters	38 specimens	75–10 mm.
Off Thatchers I. Aug. 24	0 “	4 “	7–8 “
Station 10306	110–0 meters	1 specimen	13 “
“ 10320	50–0 “	65 specimens	5–9 “
“ 10321	25–0 “	50 “	4.5–8 “
“ 10321	bottom net	66 “	6–13 “
“ 10323	70–0 meters	16 “	6–8 “
“ 10330	25–0 “	40 “	5–8 “
“ 10335	8–0 “	1 specimen	6 “
“ 10336	40–0 “	15 specimens	10–19 “
“ 10337	40–0 “	6 “	6–9 “
“ 10337	bottom net	11 “	7–10 “
“ 10338	60–0 meters	25 “	5–10 “

GADIDAE.

Gadus callarias Linné.

1913.[1]

1 mile off Magnolia, Mass.	16 specimens	4–8 mm.
Station 10057	1 specimen	13 “

1914.

Station 10229	80–0 meters	1 specimen	51 mm.
“ 10230	40–0 “	1 “	23 “
“ 10236	65–0 “	1 “	15.5 “

1915.

Station 10300	59–0 meters	17 specimens	10–31.5 mm.

Melanogrammus aeglifinus (Linné).

1913.[1]

40° 43′ N.; 70° 12′ W.: June 5	9 specimens	16–27 mm.
43° 48′ N.; 70° 05′ W.: “ 6	1 specimen	20 “
Station 10057	3 specimens	9–11 “
“ 10058	2 “	29 & 64 “
“ 10085	5 “	54–109.5 mm.
“ 10087	1 specimen	128.5 “

1915.

Station 10300	59–0 meters	11 specimens	8–15 mm.

Brosmius brosme (Müller).

1915.

Station 10330	59–0 meters	3 specimens	7.5–8.5 mm.

Urophycis chuss (Walbaum).

1914.

Shelburne Harbor, N. S.	surface	1 specimen	72 mm.

Urophycis chesteri Goode & Bean.

1914.

Station 10258	surface	2 specimens	25 & 35 mm.
“ 10258	25–0 meters	9 “	5–6 “
“ 10259	50–0 “	3 “	8–10 “

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[1] For the location of Stations see 1915, p. 342.

Urophycis tenuis (Mitchill).

1915.

21 miles So. of Mt. Desert Rock	Aug. 6	surface	1 specimen	71 mm.

Urophycis sp.?

1915.

Station 10332	45–0 meters	9 specimens	21–32 mm.
" 10333	70–0 "	7 "	8–13 "
" 10335	8–0 "	1 specimen	6.5 "

Enchelyopus cimbrius (Linné).

1914.

Station 10251	surface	2 specimens	21 & 4 mm.
" 10256	130–0 meters	1 specimen	10 "

1915.

Station 10300	59–0 meters	1 specimen	7.5 mm.
Kittery Harbor Aug. 2	0 "	18 specimens	17–42 "
6 m. off Thatchers Island, Aug. 24	0 "	6 "	6.5–35 "
Station 10319	25–0 "	1 specimen	34 "
" 10320	50–0 "	1 "	6 "
" 10321	25–0 "	14 specimens	4.5–11 "
" 10330	25–0 "	2 "	4.5–5.5 "

PLEURONECTIDAE.

Hippoglossoides platessoides (Fabricius).

1914.

Station 10213	50–0 meters	1 specimen	21 mm.
" 10215	70–0 "	2 specimens	10–13.5 "
" 10236	65–0 "	2 "	16.5 & 30 "
" 10237	75–0 "	2 "	19 & 21.5 "

1915.

Station 10279	60–0 meters	16 specimens	12–18.5 mm.
“ 10280	15–0 “	5 “	8–10 “
“ 10300	59–0 “	97 “	7–21.5 “

Limanda ferruginea (Storer).

Station 10224	60–0 meters	5 specimens	12–16 mm.
“ 10258	25–0 “	2 “	12.5 & 15.5 “

Glyptocephalus cynoglossus (Linné).

1914.

Station 10258	25–0 meters	19 specimens	10–19 mm.

1915.

Station 10300	59–0 meters	109 specimens	8–23.5 mm.
“ 10311	50–0 “	1 specimen	20.5 “
“ 10320	50–0 “	22 specimens	10–14 “
“ 10321	25–0 “	11 “	8–16 “
“ 10321	bottom net	5 “	12–15 “
“ 10329	40–0 meters	1 specimen	35 “
“ 10330	25–0 “	1 “	9.5 “

Lophopsetta maculata (Mitchill).

1915.

Station 10337	60–0 meters	1 specimen	6 mm.

Monolena sessilicauda Goode. (Symmetrical larvae)

Station 10218	60–0 meters	1 specimen	39 mm.
“ 10218	400–0 “	1 “	45 “

LOPHIIDAE.

Lophius piscatorius Linné.

Station 10321	25–0 meters	1 specimen	5 mm.

It would be premature to draw any general conclusions from the scanty data as to distribution of fish fry in the Gulf of Maine, though some features of the preceding list may be noted.

Perhaps the most interesting, certainly the most unexpected of these, is that young Cod and Haddock have appeared so seldom in the hauls, though both these species, particularly Haddock, spawn in large numbers in the Gulf; their eggs occurring more regularly in the townets than those of other fish (p. 257); and we have never taken any Mackerel fry in the Gulf, though Mackerel eggs are by no means rare there (p. 264). Since the nets in use were all adapted to the capture of the small fry, and did yield considerable numbers of other young fish, notably Sebastes, and Merluccius, it can hardly be supposed that if Cod and Haddock larvae were as numerous as Silver Hake fry the nets would consistently miss the one, and capture the other. Consequently, even if the youngest pelagic stages of Cod and Haddock are not as rare in the Gulf as the records suggest, there is good reason to conclude that they are not abundant there during the summer. Furthermore, the few records of young Cod and Haddock are all grouped in the southwest corner of the Gulf (Fig. 86), though their eggs were as abundant in the east as in its west side; and our

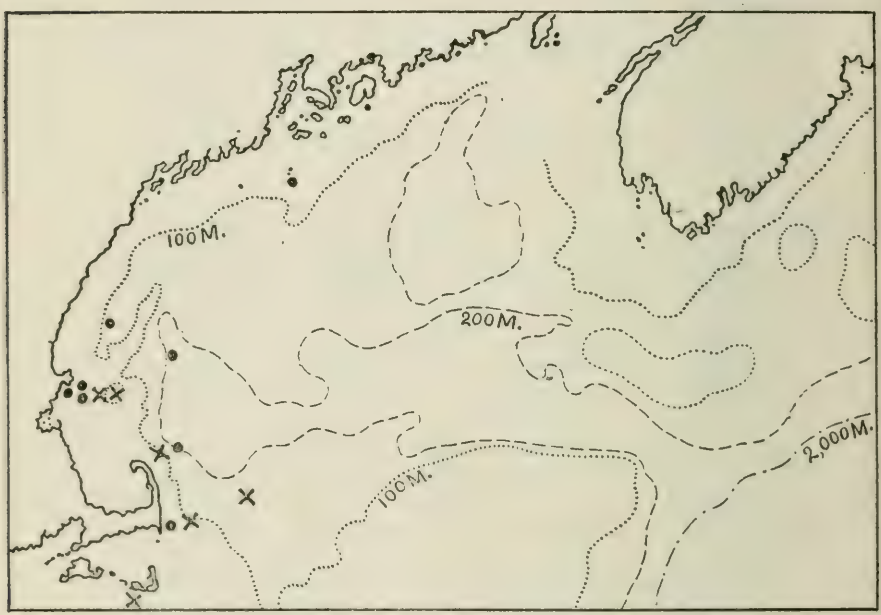

FIG. 86. GRAMPUS records for larval cod, ●, and larval haddock, X, 1912–1915.

captures of Silver Hake fry are similarly limited to the immediate neighborhood of the coast in the southern and southwestern corner of the Gulf (Fig. 83) though its eggs occur all along the coastal zone from Cape Cod to Nova Scotia; and this has so consistently been the experience for the past four summers, during which so many hauls have been made in various parts of the Gulf, that it must be accepted as the normal condition for the summer.

All this, of course, suggests a migration, or rather drift, of the young fry, westerly and southwesterly around the periphery of the Gulf of Maine, past Cape Cod, and so either to Nantucket Shoals or Georges Bank; and, such a movement would agree very well with the circulation of the Gulf (p. 234), while, as is now well known, the young Cod in Norwegian waters perform even more extensive migrations, due to hydrographic causes (Hjort, 1914). But this suggestion must be tested much more extensively before it can be accepted as proved.

In northern European waters the European Hake is regarded as a southern or summer fish, and the distribution of the eggs and larvae of the Silver Hake, particularly the great abundance of the latter off Marthas Vineyard and further west in 1913 (Stations 10063, 10070) indicates that this is likewise true of the Silver Hake as compared with such typical boreal species as the Cod or Haddock. But though Cod and Hake have rather different faunistic relationships, when their eggs are spawned side by side in the Gulf, as is the case in summer (p. 261), they are subject to similar conditions, and would necessarily undergo similar migrations if any; and such a migration, around the Gulf, if it actually takes place, would explain, not only the geographic location of our records for the Silver Hake fry (Fig. 83); but also the fact that in summer they are so much more abundant in the Gulf than young Cod or Haddock, because the chief spawning of the latter takes place in autumn, winter (Cod), and early spring (Haddock), so that their fry would naturally have drifted out of the northern part of the Gulf by late spring and summer, when most of our work has been done. Silver Hake, on the other hand, spawn chiefly in summer in the Gulf. It is, of course, obvious that if this be a true picture, it presupposes an immigration of small fish back into the Gulf, to maintain the rich population of gadoids, both large and small, which obtains there; and it is of course possible that more or less regular supplies of Cod may reach the Gulf from the north, via the Cabot Current; though this can hardly be supposed for the Haddock.

But our actual knowledge along this line being practically *nil*, I can only point out some of the vistas which the demonstration of the existence of a drift of young fish around the Gulf, such as the results suggest, would open up. Elucidation of this general problem offers a fertile field for study, of great economic importance.

The commonest young fishes in our hauls and the most regularly recurrent in the Gulf are the larvae of the Red Fish (*Sebastes marinus*).[1] Enough have now been taken to show that they may be expected anywhere in the Gulf in summer (Fig. 87), especially between the coast and the 200 meter contour, and near the offshore Banks; we have even

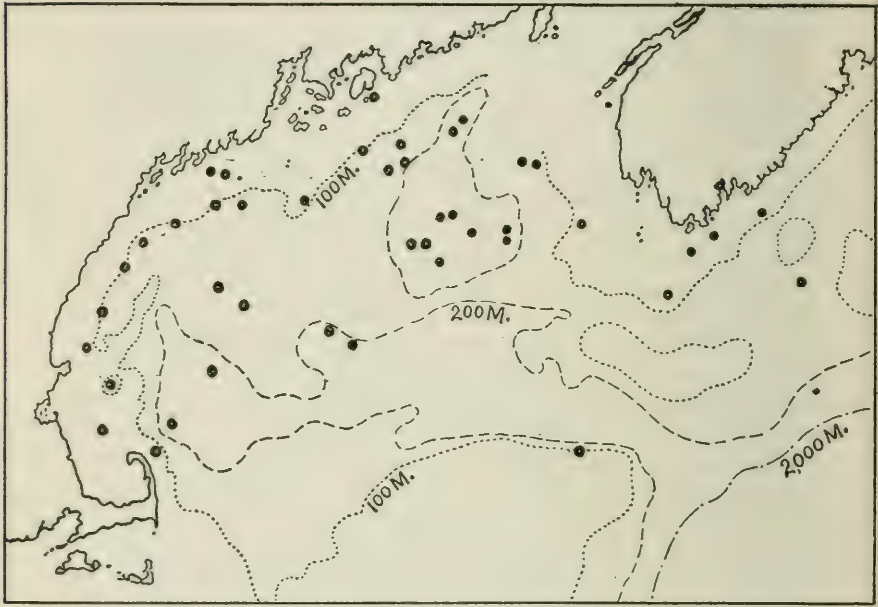

Fig. 87.— Grampus records for larval Sebastes, 1912–1915.

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[1] The captures of Sebastes larvae in July and August, 1913, are as follows: —

Station 10057	off Cape Cod	57	specimens
10087	" " Ann	152	"
10089	West of Cashes Ledge	19	"
10090	East of " "	224	"
10091	Jeffrey's Bank	49	"
10092	Eastern Basin	5	"
10093	" "	9	"
10097	" "	11	"
10100	Off Mt. Desert Rock	2	"
10102	" Monhegan I.	12	"

taken them in such partially enclosed waters as South West Harbor, Mt. Desert Island. Red Fish also breed on Georges Bank, where Mr. W. W. Welsh found females with young in June, 1912, though we have only once taken fry there (Station 10226); and though the young have not occurred in the hauls on Brown's, or Le Have Banks, or over the outer part of the shelf off Nova Scotia, their absence there is probably only apparent, in view of the records in the Northern Channel, near Cape Sable, and off Roseway Bank (Stations 10229, 10232, 10243). The largest catches of Red Fish larvae were made off Cape Elizabeth and on Platts Bank in 1912 (1914a); near Cashes Ledge in 1913; off Roseway Bank and Cape Sable in 1914 (Stations 10232, 10243); near Monhegan Island (Station 10303) and near Cashes Ledge (Station 10308) in 1915. Most of the records are from 40 or more meters, but they occasionally occur in large numbers on the surface. Their numbers in the Gulf, locally (*e. g.*, Station 10308) rival the swarms encountered by Schmidt[1] between Iceland and the Faroes (Ehrenbaum, 1905–1909, p. 52). The general and common occurrence of Red Fish larvae in the Gulf might at first seem an argument against the possible drift of gadoid larvae thence out onto Georges Bank (p. 279), on the ground that Red Fish would undergo a similar migration, resulting in a similar rarity of its fry in the Gulf. But when examined critically this argument loses weight, first, because Red Fish eggs are not pelagic; hence the period during which the species is subject to involuntary migrations is shorter; secondly and more important, because its reproduction takes place pretty much all over the Gulf, instead of in the coastal zone only, consequently, while the fry hatched near land are subject to the same conditions as Cod or Haddock, large numbers of Red Fish are likewise produced in the center of the Gulf outside the effective influence of its eddy-like circulation.

The occurrence of the young flounders, species of Hippoglossoides and Glyptocephalus, are interesting chiefly as indicating the spawning season (p. 276).

The only other economically or faunistically important species whose fry occur in any numbers in our hauls is the Herring (p. 268); but as this is now being made the subject of special study by the Bureau of Fisheries, the mere list of records will suffice.

Euphausiids.— The Euphausiids taken in 1914, identified by W. M. Tattersall, are listed in the following table.

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[1] I have not had access to Schmidt's account, in Skifter udg, Kommission for Havundersogelser, 1904, no. 1, p. 46.

Grampus Station No.	Date. 1914.	Depth Meters	Thysanopoda acutifrons H. & T.	Meganyctiphanes norvegica M. Sars	Euphausia krohnii Brandt	Euphausia tenera Hansen	Euphausia hemigibba Hansen	Thysanoessa inermis Kroyer	Thysanoessa raschii M. Sars	Thysanoessa longicaudata Kr.	Thysanoessa gregaria G. O. Sars	Nematoscelis megalops G. O. Sars	Stylocheiron abbreviatum G. O. S.
10213	19/7	70–0		19 juv.				5					
14	19/7	100–0		5				5					
16	20/7	60–0						2			93		
20	22/7	80–0		1						6	49	3	
20	22/7	400–0			17	3	1					19	
23	23/7	60–0		2				abd.		5			
25	23/7	60–0		1									
25	23/7	240–0	5					1		8		2	
26	24/7	70–0						89					
27	24/7	180–0			10					6	4	3	
28	24/7	60–0		mod.				mod.		mod.	few	few	
29	25/7	80–0						ca 50		12	1	3	
30	25/7	40–0						ca 50					
31	27/7	0						30	4				
32	28/7	60–0		1					1				
32	28/7	100–0						16				2	
33	28/7	0			abd.			1					
33	28/7	100–0			abd.					mod.	few	abd.	
33	28/7	400–0				1				4		abd.	
34	29/7	75–0						23		2		2	
35	29/7	80–0						1		14			
37	6/8	75–0		1				1		4			
43	11/8	40–0						abd.					
46	12/8	150–0		181				1	1	6			
47	12/8	0						4					
48	13/8	150–0		24				7		21			
49	13/8	50–0						1		16			
49	13/8	175–0		3				9	1	32		6	
50	14/8	120–0						2		5			
53	22/8	80–0		4				abd.		few			
54	22/8	0		13				12					
54	22/8	75–0		38				11		15	12		
54	22/8	225–0		50				16		35	7		
55	22/8	150–0								5			
56	23/8	0		8							2		
56	23/8	130–0		35				25		18	4	15	
58	25/8	25–0						2					
59	25/8	50–0						abd.	2	1			
61	26/8	400–0			47					10	6		2

Euphausiids, though taken at most of the stations both in 1914 and in 1915, seldom formed an important constitutent of the plankton. However, the haul on Brown's Bank in July, 1914 (Station 10228, p. 245, Fig. 79) at 60 meters yielded 500 cc. of small individuals of three species of *Thysanoessa*, *T. gregaria*, *T. longicaudata*, and *T. inermis*, with a few *Nematoscelis megalops*, and large *Meganyctiphanes norvegica*. A few days later we again found a euphausiid plankton, over the continental slope off Shelburne, Nova Scotia (Station 10233, p. 245, Fig. 79) where half hour hauls on the surface, at 100 meters and at 200 meters yielded respectively 125 cc., 500 cc., and 250 cc., with very little else. In this case the surface catch consisted of *Euphausia krohnii*, the catch at 400 meters being *Nematoscelis megalops*, with a mixed swarm of the two at 100 meters. Swarms of euphasiid larvae were likewise taken on the surface off Cape Cod in August, of that year (Station 10264) in company with great numbers of large Calanus, while at Stations 10246 and 10254, the nets yielded a swarm of *Meganyctiphanes norvegica*.

In 1915 we again found Nematoscelis and Euphausia in large numbers over the slope off Shelburne (Station 10295), though the hauls on Brown's Bank (Station 10296) yielded none at all. The most notable occurrence of euphausiids during that summer was the reappearance of *Meganyctiphanes norvegica*, associated with the large copepod Euchaeta, in the northeast corner of the Gulf, where it was abundant in the deep haul (125–0 meters) in May (Station 10273); swarmed at about 100 meters in June (Station 10283) and was plentiful in the deep water (150–0 meters) in August (Station 10304). But although it was abundant at this same locality both in 1913 and 1914, not a single specimen was taken there in 1912 (1914a). At only two other localities in 1915 did euphausiids (*Thysanoessa inermis* in each case) form a large part of the catch, in the Eastern Basin in May (Station 10270) and off Cape Ann in August (Station 10306).

Thysanoessa inermis[1] is the commonest euphausiid in the Gulf of Maine, occurring at most of the stations there in 1914 (p. 282), and at twenty stations in 1915 (Stations 10270, 10271, 10273, 10275, 10277, 10279, 10283, 10288, 10290, 10291, 10293, 10304, 10306, 10307, 10309, 10310, 10318, 10329, 10332, 10333). But it was lacking in the hauls over the southern edge of Georges Bank, in the Eastern Channel, and at all the stations outside the continental slope, except for a single specimen at 10233. Hansen (1915)[2] records it from off Cape Cod,

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[1] I follow Hansen (1911) in including both *Th. inermis* and *Th. neglecta* under this name.

[2] Hansen, in this paper, lists all the earlier captures by the various vessels of the U. S. Bureau of Fisheries in this region.

Brown's Bank, the coastal water south of Nova Scotia, the Woods Hole region, and over the continental shelf south of Marthas Vineyard; but not from the continental slope. His failure to find it in the large collections from outside the 100 fathom curve off Marthas Vineyard can hardly be accidental, as hosts of other euphausiids have been taken there on many occasions. In short, *T. inermis* is a characteristic inhabitant of the cold coastal water from southern Nova Scotia, as far west as Long Island. But it is evidently not at home in the high temperatures outside the continental slope, though of course it may be accidentally swept out into the Gulf Stream by the mixture of the two waters which takes place there. Its rarity or absence off Halifax in 1914 reflects the local rarity of the group and poverty of the macroplankton as a whole (p. 309).

Thysanoessa longicaudata, likewise a boreal species (Kramp, 1913, Zimmer, 1909) is as generally distributed in the Gulf as *T. inermis*. But it occurred less regularly, and at fewer stations in 1912, 1914, and especially in 1915 (when it was detected only once, Station 10304). On the other hand, it was taken at three deep stations over the slope, though not at the one (Station 10218) where salinity and temperature were most characteristically oceanic, and Hansen (1915) likewise records it from many stations over the continental slope, and the edge of the Gulf Stream south of Marthas Vineyard. Apparently it is less definitely associated with the coast water than is *T. inermis*.

Thysanoessa raschii, likewise a northern form (Kramp, 1913, Zimmer, 1909), is much less common in our waters in summer than either of the preceding species, for it was not represented at all in the hauls in July 1912; appeared at only five stations in 1914 (two in the Gulf, two in the cold water off southern Nova Scotia, Stations 10231, 10232, one off Marthas Vineyard, Station 10259); and at three Stations (10277, 10318, 10329) in 1915. But it swarmed in the western part of the Gulf during the early spring of 1913 (1914b). Hansen's (1915) records are chiefly from the Gulf of St. Lawrence. But they include one station on Brown's Bank, August 1877, and one off the northern end of Cape Cod, August 1881. Apparently the Gulf of Maine is the extreme southern limit for this species in summer.

The occurrence of *Thysanoessa gregaria*, side by side with *T. inermis* and *T. raschii* is, as Dr. Tattersall writes me, an interesting phenomenon, because, unlike them, it is a typical subtropical form (Zimmer, 1909), its presence, like that of Salpa, and other tropical animals, indicating the presence of southern, *i. e.*, ocean, waters in the Gulf (p. 239). *Thysanoessa gregaria* is much less common in the Gulf than *T. inermis*, but the records for 1912 (1914a, p. 412), 1914 (p. 282) and 1915 (Stations 10306, 10307, 10308, 10310, 10318) show that it may be expected anywhere there, likewise on Brown's and Georges Banks, in the Eastern Channel, and in the waters outside the continental slope. Its absence in the cold coast water off Nova Scotia is explained by its southern origin. Hansen (1915) records it at two oceanic stations south of Marthas Vineyard. Our data, particularly its occurrence in 1915, when it was not detected until August, suggest that it increases in numbers, and penetrates further and further into the Gulf, as summer advances.

The captures of *Meganyctiphanes norvegica* in 1912, 1913, 1914, and 1915 show that it may be expected anywhere in the Gulf of Maine and in the cold water off southern Nova Scotia. The GRAMPUS did not find it in Massachusetts Bay in 1912, 1914, or 1915 but Hansen (1915) records it there; and although we did not take it in any of the oceanic hauls, he lists it in small numbers from many stations outside the continental slope south of Marthas Vineyard, for the summers of 1880–1894, and once off the southern edge of Georges Bank. Off this coast Meganyctiphanes appears to be most abundant near land, though it also extends seaward to the zone of mixture between coastal and Gulf Stream water, which agrees with its general occurrence on the other side of the north Atlantic (Kramp, 1913; Tattersall, 1911). But while in European waters it is generally most abundant in regions where the depth is as great as 150 fathoms (Holt & Tattersall, 1905; Tattersall, 1911; Kramp, 1913), in the Gulf of Maine it often swarms in the shallow water of harbors and bays.

Nematoscelis and Euphausia are typical oceanic species (Holt & Tattersall, 1905; Tattersall, 1911; Kramp, 1911). The former was taken once in 1912 (1914b, p. 411); and in 1914 it was encountered only twice in that part of the Gulf covered by previous cruises (1914a, 1915). But it likewise occurred in small numbers in the southeast corner of the Gulf, in the Eastern Channel, off the southeast face of Georges Bank, on Brown's Bank, and on Le Have Bank. It was abundant in the deep hauls over the slope south of the latter, both in 1914 (p. 282) and in 1915 (Station 10295, p. 283). Hansen (1915) does not record Nematoscelis from the Gulf of Maine, from Georges Bank nor indeed from the continental shelf north and east of Cape Cod; but he lists it from many localities over the continental slope, particularly south of Marthas Vineyard.

Euphausia krohnii is apparently even more oceanic in our waters than Nematoscelis, for it was only in the Eastern Channel and over the continental slope (Stations 10233 and 10261, in 1914, Station 10295 in 1915) that it was taken; and Hansen's (1915) numerous records are all either from the oceanic water outside the continental slope, or from the outer part of the shelf. Its abundance at Station 10233, and its bathymetric distribution there relative to that of Nematoscelis is noted above (p. 283).

Hyperiid Amphipods.— Hyperiid amphipods are chiefly represented in the collections by two species of Euthemisto, *E. compressa* and *E. bispinosa.* In 1914 these two combined, formed a considerable portion of the volume of the horizontal hauls over the continental shelf as a whole south of Nova Scotia; on the southern and western parts of Georges Bank; and on the shelf south of Marthas Vineyard (p. 245), being especially numerous off Cape Sable (Station 10229), west of Le Have Bank (Station 10232), south of Marthas Vineyard (Station 10259) and along the southern half of Georges Bank (Stations 10216–10219); and one or the other, or both, occurred at every one of the Stations.

While exact numerical results can not be expected from horizontal hauls, it may be of interest to note that about 1000 cc. of large Euthemisto were taken in a half-hour haul on the surface in a 1 meter-net on Brown's Bank (Station 10228); 750 cc. on the surface off Shelburne; and about 1000 cc. of medium sized specimens at 40 meters off Cape Sable (Station 10243) in hauls of the same duration. This abundance is apparently characteristic of these waters, for Euthemisto again formed a considerable part of our catches on the shelf south of Nova Scotia (Stations 10291–10294); on Brown's Bank (Station 10296) and off Marthas Vineyard (Stations 10332, 10333) in the summer of 1915. Euthemisto is more or less seasonal in its occurrence in the Gulf, for only occasional specimens were taken in May; and it was not until June 19 (Station 10288) that it appeared in any numbers in the tow.

Very large adults, with eggs, were taken very generally over the whole area both in 1914 and in 1915. But the chief breeding areas, as indicated by relative abundance, are over the continental slope, (Station 10220, 10261); the central and northwestern parts of Georges Bank (Station 10215, 10216, and 10219); on Brown's Bank (Station 10228), and off Shelburne (Station 10231). In fact, young larvae were numerous on the surface, adults, with eggs, in the deep haul, both on Georges Bank in 1914, (Stations 10215 and 10219), and off Shelburne (Station 10293) in 1915. But there is no apparent correlation between these spawning areas and hydrography, since they cover nearly the entire range of both salinity and temperature for the general area under study.

The proportionate abundance of the two species[1] in the summer of 1914 is shown in the following table, which gives the relative numbers in samples from each haul.

STATIONS AND DEPTHS IN METERS.

	10213	10214	10215		10216	10218		10219		10220		10223	10224	10225	10226	10227	10228	
	70–0	100–0	50–0	70–0	60–0	60–0	300–0	0	80–0	80–0	400–0	60–0	60–0	60–0	70–0	180–0	0	60–0
compressa	12	7	11	6	6	2	6	S[2]	5	9	15	0		17	22	4	4	21
bispinosa	0	9	13	3	13	2	1		14	8	4	86		3	6	5	35	14

	10229		10230	10231	10232		10233			10234	10237	10242	10243	10245	10245	10240		
	0	80–0	40–0	0	60–0	100–0	0	100–0	300–0	75–0	75–0	0	40–0	0	100–0	0	50–0	150–0
compressa	4	20	9	25	10	23	3	25	5	16	6	S[2]	4	4		11	13	8
bispinosa	29	2	8	14	5	11	1	17	4	14	18		15	17		8	8	5

	10247	10248		10249		10250	10253	10254			10255	10256	10258	10259	10260	10261
	0	50–0	150–0	50–0	175–0	120–0	80–0	0	75–0	225–0	150–0	130–0	25–0	50–0	140–0	400–0
compressa	2	3	7	9	11	7	4	3	3	2	7	8	0	0	4	19
bispinosa	3	0	9	22	19	6	0	0	3	6	1	4	30	20	36	3

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[1] Identifications follow Sars, 1890–1895.

[2] S, = Swarm of the two species combined.

For distributional purposes we may divide the stations into three classes:— first those where *E. compressa* was twice as numerous as *E. bispinosa*, at one level at least, and about equal to it in numbers at the other; second, the reverse; and thirdly stations where the two were either nearly equal in numbers, or where one greatly predominated at one, the other at another depth. On this basis *E. compressa* predominated in the southwest part of the Gulf of Maine, and locally in its northeast corner (Stations 10246, 10248), on the northeast edge of Georges Bank (Station 10226), over the outer part of the shelf south of Shelburne, Nova Scotia; and probably all along the continental slope (Stations 10218, 10220, 10233, 10261). *E. bispinosa* outnumbered *E. compressa* in the eastern part of the Gulf, in the Northern Channel, on Brown's Bank, locally off Halifax (Station 10237), and over the southern part of Georges Bank.

In 1915 *E. compressa* was the more numerous of the two in the Gulf in May and June; but in the latter month *E. bispinosa* predominated over the outer part of the shelf off Shelburne (Station 10294) as well as on Brown's Bank (Station 10296). In August *E. bispinosa* predominated in the Western and Eastern Basins (Stations 10307, 10310) and on German Bank (Station 10311), while it outnumbered *E. compressa* locally off Marthas Vineyard (Stations 10331–10333), off Cape Cod and in Massachusetts Bay in October (Stations 10336, 10337). These records suggest that while *E. compressa* is a permanent and characteristic inhabitant of the Gulf, *E. bispinosa* is absent, or at least rare, there in spring, appearing in summer, when it may locally outnumber *E. compressa*, particularly in the eastern half of the Gulf. But it is very rarely as numerous as *E. compressa* in the coast water of the western side of the Gulf, and that only in autumn, as just noted, and in winter (1914b, p. 410).

In the coast waters off Nova Scotia *E. bispinosa* is faunistically more important, usually equalling if not outnumbering *E. compressa*, particularly over the outer part of the shelf. We have always found it the predominant member of the pair in the shallow waters south of Marthas Vineyard, and on the southern part of Georges Bank. In the coast water east of Cape Cod, *E. bispinosa* is apparently the more oceanic of the two. But the difference between the two, in this respect, is one of relative abundance only, for they occur together in most of our hauls, and it is difficult to correlate the predominance of one, or the other with hydrography, or with depth, though *E. bispinosa* has more often outnumbered *E. compressa* in deep, than in shallow hauls, especially at localities where both species are abundant.

The occurrence of hyperiid amphipods other than Euthemisto, in 1914, is given in the following table.

	10218 60–0	. 300–0	10219 80–0	10220 400–0	10231 0	10233 0	10235 80–0	10237 75–0	10248 50–0	10260 140–0	10261 100–0
Oxycephalus sp.		3									
Hyperoche abyssorum						2	1	1	1		
Parathemisto oblivia					1			5			
Phronima sedentaria		4	1	2							6
" atlantica	51	17	1							1	
Phrosina semilunata	25										
Phronimella elongata	3										
Vibilia sp.		2									

In 1915 *Parathemisto oblivia* was taken again off Shelburne (Station 10291, five specimens); *Hyperoche* and *Hyperia* at several stations in the Gulf: Phronima on Brown's Bank (Station 10296) and off Marthas Vineyard (Station 10333).

The rarity of Parathemisto reproduces our experience in previous years (1914a, 1914b, 1915), and its repeated occurrence close to the southern coast of Nova Scotia suggests that when it does reach the Gulf, it is brought thither by the St. Lawrence water.[1] Hyperoche was much more common in 1912 and 1913 than in 1914 or 1915 and more generally distributed; and neither of the two species of Hyperia, *H. galba* and *H. medusarum*, was found in 1914, though both were common in previous summers. Especially interesting is the large haul of oceanic warm water species at Station 10218. Two of these, Phronimella and Phrosina, are now recorded for the first time from our waters so far as I can learn (Holmes, 1895). But as both are widely distributed in the Atlantic (Bovallius, 1889) there is nothing remarkable in their occurrence in the inner edge of the Gulf Stream.

Copepods.— Our records for this group in the Gulf of Maine add little except in the way of verification, to those for 1912 (1914a) and 1913 (1915).

In 1914 and 1915 as in previous summers, *Calanus finmarchicus* was universal, not only in the Gulf but on Georges Bank, and in the coastal waters south of Nova Scotia, occurring not only at every station, but in practically every haul; by far the most important individual member of the plankton.[1] But it occurred only in small numbers over the continental slope (Stations 10220, 10233, and 10261); and was wanting both in the Gulf Stream plankton off the southwestern edge of Georges Bank (Station 10218) and over the outer part of the shelf south of Marthas Vineyard (Station 10259).

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[1] Parathemisto is recorded from the Gulf of St. Lawrence by Whiteaves, 1901.

Second only to *Calanus finmarchicus* numerically, though much less important economically because of its small size, is *Pseudocalanus elongatus*, which was again found at every station in the Gulf in both years (p. 243), and on Georges Bank; as well as at most of our stations in the cold waters off southern Nova Scotia (Stations 10229–10232; 10234–10243), and locally on the shelf south of Marthas Vineyard (Station 10260). But it was lacking at all our deep stations over the continental slope, and on Brown's Bank (Station 10228) as well, which agrees with its absence in the inner edge of the Gulf Stream in 1913 (1915).

The records in 1914, for copepods other than *Calanus finmarchicus* and *Pseudocalanus elongatus*, as identified by Dr. C. O. Esterly, are listed in the following table. Only a preliminary examination has yet been made of the copepods taken in 1915.

	10213 70–0	214 100–0	215 70–0	218 60–0	300–0	219 80–0	220 400–0	223 100–0	224 60–0	225 240–0	227 80–0	228 60–0	229 80–0	230 40–0
Calanus hyperboreus														
Rhincalanus nasutus				×	×		×							
" *cornutus*				×										
Eucalanus attenuatus				×	×									
" *elongatus*				×	×									
Eucheirella rostrata			×	×		×				×				
Euchaeta norvegica	×	×	×							×				
Centropages typicus														
Temora longicornis		×							×	×				
Metridia lucens	×							×		×	×	×	×	×
Heterorhabdus spinifrons					×		×							
Anomalocera pattersoni														
Pleuromamma gracilis							×							
" *robustum*														
" *abdominalis*														
Acartia longiremis														
Candacia Sp.?														

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[1] The numerical occurrence of Calanus is discussed elsewhere, p. 317.

	10232 100–0	233 60–0	400–0	240 50–0	245 0	100–0	246 0	50–0	150–0	247 0	248 150–0	249 50–0	175–0
Calanus hyperboreus	×											×	
Rhincalanus nasutus													
" *cornutus*													
Eucalanus attenuatus													
" *elongatus*													
Euchirella rostrata		×						×					
Euchaeta norvegica	×	×				×			×	×	×	×	×
Centropages typicus							×						
Temora longicornis													
Metridia lucens		×	×	×	×	×		×	×	×	×		×
Heterorhabdus spinifrons													
Anomalocera pattersoni					×		×			×			
Pleuromamma gracilis													
" ***robustum***			×										
" ***abdominalis***									×				
Acartia longiremis													
Candacia Sp.?													

	10250 120–0	251 0	253 80–0	254 0	25–0	75–0	255 150–0	256 0	130–0	258 25–0	259 50–0	260 140–0	261 400–0
Calanus hyperboreus													
Rhincalanus nasutus													
" *cornutus*													
Eucalanus attenuatus													
" *elongatus*													
Euchirella rostrata													
Euchaeta norvegica				×	×	×		×	×				
Centropages typicus				×								×	
Temora longicornis													
Metridia lucens	×		×				×	×	×			×	
Heterorhabdus spinifrons													
Anomalocera pattersoni	×			×						×	×		
Pleuromamma gracilis										×		×	×
" ***robustum***													
" ***abdominalis***													
Acartia longiremis		×											
Candacia Sp.?			×										

Calanus hyperboreus belongs fundamentally to the Arctic community (Farran, 1910, Murray and Hjort, 1912). Its occurrence in the Gulf of Maine agrees with its general distribution in so far as it was most abundant at the season (May and June) when northern water is at its maximum there; and its fluctuations off southern Nova Scotia, where it was about as numerous as *C. finmarchicus* in June, lacking in August, correspond with those of the Cabot Current. Hence, its numbers in the Gulf must receive annual accessions from the North. But its sporadic appearance here and there in the Gulf, at all seasons, together with the fact that even in spring it was rare or absent just where Cabot Current water was most in evidence (Stations 10270–10272), suggests that it may also be endemic in the Gulf of Maine.

Metridia lucens was practically universal in the Gulf of Maine in 1914, as in past years, though never abundant there. It was as generally distributed over the Gulf throughout the spring and summer in 1915, though much less numerous in that year when it was detected at only about half the stations.[1]

In 1914 it occurred in several surface hauls, instead of being restricted to depths of 25 meters or more, as was the case the year before (1915, p. 295).

Euchaeta norvegica played much the same rôle in the Gulf in 1914 and 1915 as in 1912 and 1913 (Fig. 88), occurring in most horizontal hauls deeper than 100 meters, sporadically at higher levels; and even on the surface both in the Gulf (Stations 10247, 10254, 10256) and off Shelburne (Station 10294). But although the surface hauls have occasionally yielded considerable numbers of Euchaeta (*e. g.*, Station 10032 in 1912; 1914a, p. 104) it is far more numerous and regular in its occurrence in the depths of the Gulf, of which it is one of the most characteristic inhabitants; as it is of the mid-layers of the Norwegian Sea (Gran, 1902); and almost all the records for Euchaeta have been from outside the 100 meter curve, no matter at what depth the specimens were taken. As a rule Euchaeta occurs in small numbers only, so much so that it seldom appears in the vertical hauls. But it was abundant in the northeast corner of the Gulf both in 1914 and in 1915 (p. 250).[2]

Temora longicornis and *Anomalocera pattersoni* have markedly diminished in the Gulf of Maine since 1913 (p. 290). The latter, a species so conspicuous, both in life and after preservation, that it is not likely to be overlooked, was detected at only four stations in 1915 (Stations 10303, 10307, 10308, 10314), instead of being widely distributed as in former years (p. 295). On the other hand the 1915 hauls add one species, *Eucalanus elongatus*, to the list of the Gulf of Maine copepods (Station 10253), interesting because it is a typical warm water, oceanic form (Farran, 1911), not previously recorded from the general region. The records of *Rhincalanus nasutus* (Station 10272, 10273), *Eucheirella rostrata* (p. 246, Stations 10270, 10294, 10310) and *Pleuromamma abdominalis* in the Gulf (p. 246) are likewise worth noting, because of their oceanic origin.

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[1] *Metridia lucens* occurred at the following Stations in 1915: 10270, 10272, 10273, 10278, 10279, 10282, 10283, 10284, 10286, 10294, 10295, 10299, 10304, 10306, 10307, 10308, 10309, 10311, 10314, 10315, 10318, 10324, 10325.

[2] In 1915 Euchaeta was taken at Stations 10270, 10273, 10276, 10282, 10283, 10286, 10293, 10294, 10304, 10306, 10307, 10309, 10310.

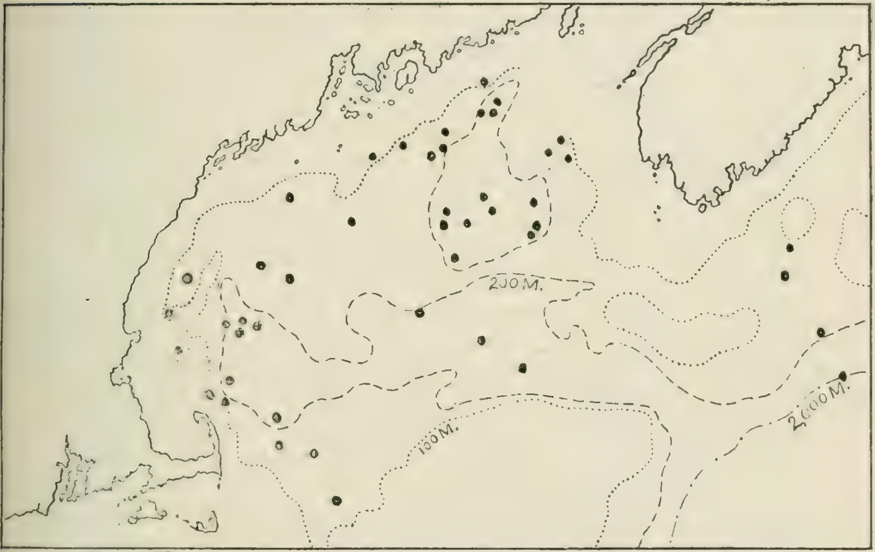

FIG. 88.— Locality records for *Euchaeta norvegica* in the Gulf of Maine and off Nova Scotia, 1912–1915.

Copepods practically disappear from the western side of the Gulf in April (1914b). But very little is known of the manner of their reappearance, *i. e.*, whether the copepod fauna is reestablished, more or less evenly over the Gulf, by the multiplication of the few which survive during the barren season; or whether it is recruited from local centers of reproduction, or by migration from outside waters. The great regional variation in number of copepods in May (p. 314), and the subsequent equalization which takes place during the summer, shows that in 1915 at least there were two distinct centers for copepods in spring, one on the western, the other on the eastern side of the Gulf;

and the fact that the richness of these decreased, while that of the nearby stations increased, is good evidence that copepods were actually dispersed from them throughout the neighboring waters.

The May swarm off Cape Ann (Station 10266) consisted chiefly of very young stages of Calanus, with occasional older stages, and of Pseudocalanus; *i. e.*, it was an actual growth center, not an evidence of immigration, and this agrees with our earlier observations that copepod nauplii appear in swarms in Gloucester Harbor in early May followed by great numbers of young Calanus in the adjacent waters later in the month (1914b, p. 407). The May swarm in the Eastern Basin (Station 10270) contained a much larger proportion of adult *Calanus finmarchicus*, with comparatively few very early stages; hence, so far as internal evidence goes, it might either have represented an immigration, or a late stage in a local reproductive cycle, the unmistakable influence of the Cabot Current in this region (p. 224) giving the first of these alternatives an *a priori* probability. But as there are no records from the waters further south or east in May, and it is not known whether copepods dwindle almost to the vanishing point in the eastern half of the Gulf in early spring as they do in the western, indeed nothing is known of the plankton there from September to May, and the question remains open.

Sagittae.— Sagittae were taken at nearly all stations, both in 1914 and in 1915; but the quantitative importance of this group, in the plankton as a whole, differed greatly in different regions. Thus in July 1914, Sagittae swarmed on the northeastern edge of Georges Bank (Station 10224, Fig. 79) and again in the Northern Channel (Station 10229), where the meter-net, at 100 meters, yielded upwards of three liters. The opposite extreme was found on Brown's Bank (Station 10228), off Shelburne (Station 10231), off Halifax (Station 10237), and off Penobscot Bay (Station 10250), where the catches were respectively, two, seven, five, and two specimens; while none were taken in the basin north of Le Have Bank (Station 10235). In 1915 Sagittae formed a considerable portion of the catch off Lurcher Shoal in May (Station 10272) and near Shelburne (Stations 10291, 10295) in June; while they swarmed in Massachusetts Bay late in September (Station 10321) and off Marthas Vineyard in October (Station 10232). But nowhere in that year were they as abundant as the local swarms of the preceding season.

Our experience has been that *Sagitta elegans* and *S. serratodentata*[1] are always, and everywhere, the most abundant chaetognaths in the Gulf of Maine (1914a, 1915), and that of the two, *S. elegans* is invariably predominant in its western part (fig. 89). In the summer of 1914 *S. elegans* was the only Sagitta taken on the northern and northwestern parts of Georges Bank, (Stations 10215, 10224), off Massachusetts Bay and Cape Cod, both in July and in August (Stations 10213, 10214, 10253, 10256, 10264); and in the Northern Channel (Station 10229). It greatly outnumbered *S. serratodentata* on the southwestern part of Georges Bank (Station 10216), and in most of the hauls on the continental shelf south of Nova Scotia (Stations 10236, 10234, 10232).

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[1] Identifications follow Ritter-Zahony 1911 and Michael, 1911.

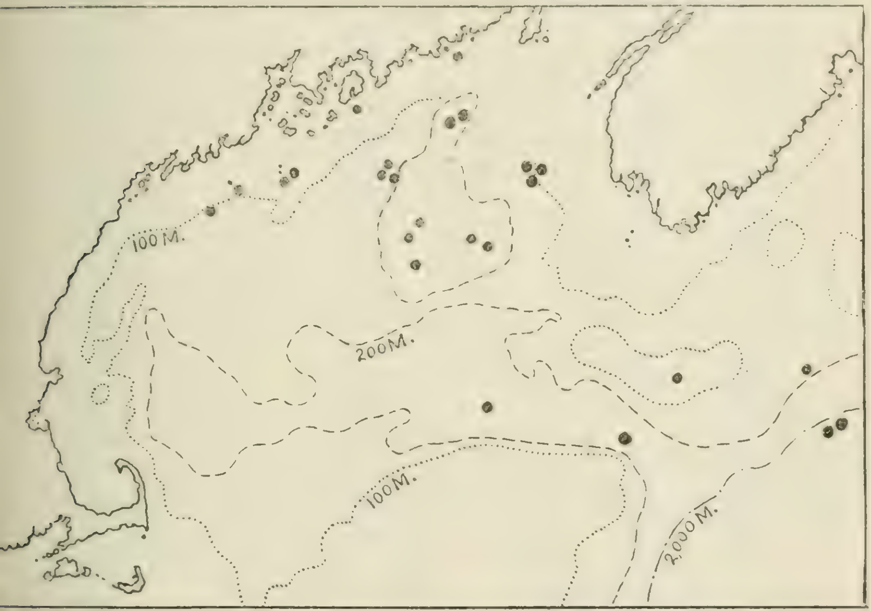

Fig. 89.— Localities indicating *Sagitta serratodentata* as abundant as, or outnumbering, *S. elegans*, 1912–1915. Only those stations where sufficient Sagittae were taken for their proportional numbers to be significant, are included.

In that year the catches off the coast of Maine (Stations 10248, 10250, 10251), on the southeastern part of Georges Bank (Station 10223), and locally off Nova Scotia, contained the two in roughly equal numbers. *Sagitta serratodentata* was much the more numerous of the two in the deep hauls in the eastern and southeastern parts of the Gulf (Stations 10225, 10245, 10246, 10249), in the Eastern Channel (Station 10227), on the southern edge of Georges Bank (Station 10219), and over the continental slope (Stations 10218, 10220, 10233). It was predominant in 1915, only locally, in the eastern and northern parts of the Gulf as illustrated by the following table, and chart (Fig. 89).

Station	Species present	Species predom.	Station	Species present	Species predom.
10266	E		10304	E,	
10270	E		10306	E, S	E
10271	E		10307	E, S	E
10272	E, S	E	10309	E, S	S
10273	E, S	E	10310	E, S	S
10275	E		10311	E, S	E
10277	E		10316	E	
10279	E		10317	E, S	E
10281	E, S	E	10318	E, S	E
10282	E, S	E	10319	E	
10286	E, S	E	10320	E, S	E
10287	E		10321	E, S	E
10288	E, S	E	10323	E, S	E
10290	E		10327	E, S	E
10291	E		10328	E, S	E
10293	E		10330	E	
10294	E, S	equal	10332	E	
10295	E, S	"	10333	E, S	S
10296	E, S	S	10337	E	
10303	S		10338	E, S	E

E = elegans. S = serratodentata.

The records for 1915, together with data previously acquired show that while *S. elegans* occurs very generally all over the Gulf probably at all seasons, (1914a, 1915), the distribution of *S. serratodentata* depends largely upon the season. Thus in May and June it was found only in the eastern part of the Gulf, in the Bay of Fundy, and off southern Nova Scotia (Fig. 90); and in four years it was detected only once (1914a, Station 10019) in the western and southwestern parts of the Gulf prior to August 1. In late summer and autumn, on the other hand, it was found at most of the stations there, and in Massachusetts Bay (Fig. 90). *Sagitta serratodentata* is the prevalent Sagitta in the coastal water south and west of Cape Cod (1915).

But in the Gulf of Maine *S. elegans* plays that rôle, except locally, in its eastern side (Fig. 89).

These facts support the general thesis that while *S. elegans* is endemic in the boreal waters of the Gulf, *S. serratodentata*, a more southern species, is carried thither and to Nova Scotian waters by the current from the southwest.

Six more species of chaetognaths have so far been detected in the collections of 1914 and 1915. *Sagitta lyra* occurred sparingly in the deep hauls in the Gulf and Eastern Channel in 1914 (Stations 10225, 225–0 M; 10227, 180–0 M; 10248, 150–0 M; 10254, 225–0 M; in 1914: Station 10310, 100–0 M; in 1915), and at most of the stations over the continental slope (Stations 10220, 10233, 10261, 10295) in hauls at 400–500 meters. But it was lacking in all shallow hauls even at these same stations. *Sagitta hexaptera* has been detected in one haul only (Station 10245, 100–0 meters, one specimen).

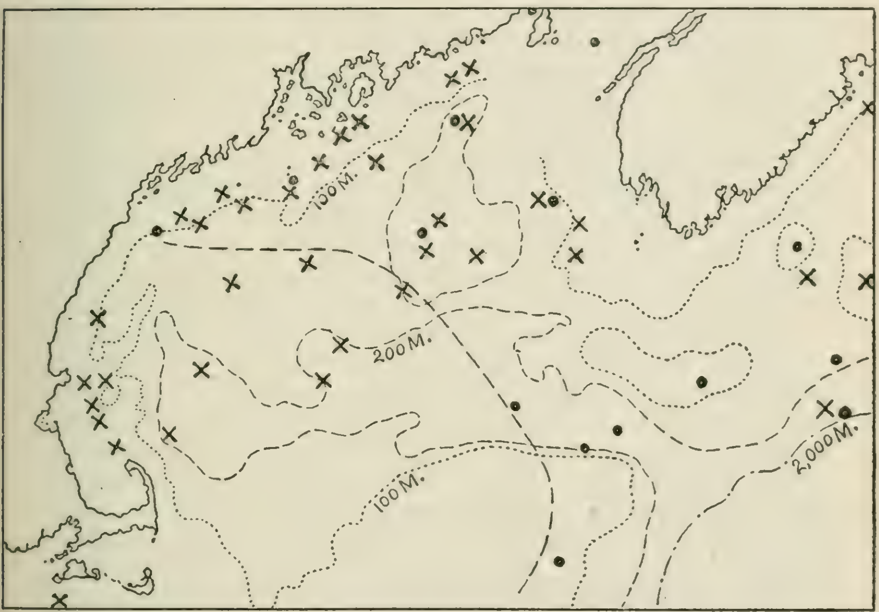

FIG. 90.— GRAMPUS records for *Sagitta serratodentata*, 1912–1915. ●, records for May–July 15; X, July 15; . . . . February; - - - - - -, western limit, May to August.

The warm water *S. enflata*, which is common south of New York

(1915, p. 300), appeared, with other tropical organisms, in the tows over the continental slope in 1914 (Stations 10218 and 10220); off Marthas Vineyard in 1915 (Station 10333, one specimen); and *Pterosagitta draco*, similarly tropical in origin, was represented by about fifty specimens in the 60 meter haul at Station 10218, a record worth noting as it has not been found before in this region, though known south of New York (1915, p. 297).

Eukrohnia hamata was taken at one station in 1912; at nine stations in the Gulf in 1913; at six stations in 1914, four in the Gulf (Stations 10225, 10246, 10248, 10254) two on the continental slope (Stations 10220, 10233). In 1915 it was taken only twice in the Gulf (Stations 10304 and 10310 in hauls from 150 and 130 meters respectively); but it also occurred in the shallow waters on Brown's Bank (Station 10296), and was abundant over the slope off Shelburne (Station 10295). The depths of the hauls range from 60–0 meters at Station 10296 to 400–0 meters at Stations 10220 and 10233; the total number of specimens being about 120. It is interesting that no *E. hamata* were taken in the 60 meter haul at Station 10225, or the 50 meter hauls at Stations 10240 and 10248, since it occurred at other depths at those localities. The largest catches were on the slope, and in the southeastern corner of the Gulf (Station 10225). I have discussed the faunal significance of this species elsewhere (1915, p. 301).

Pteropods and Heteropods.— In 1914 and 1915, as in previous years (1915, p. 303), the only members of these groups which attained any faunal prominence in the Gulf of Maine were *Limacina balea* and *Clione limacina.* In the summer of 1914 the former was numerous off Cape Cod (Station 10264), and swarmed over the northwest edge of Georges Bank (Station 10215), where about 125 cc. were taken in a haul at 50 meters. Considerable (though much smaller) catches of Limacina were likewise made at Stations 10216 and 10259; in the Eastern Channel; in the northeast corner of the Gulf (Stations 10246, 10247); and at three of the four stations on the slope (Stations 10220, 10233, 10261). But only one specimen was taken at the oceanic Station (10218) where the plankton as a whole was tropical, and at the time of our 1914 cruise it was equally wanting in the northwestern part of the Gulf (Stations 10251, 10253, 10254), though this was its chief center of abundance in 1912 (1914a). It was likewise rare, or absent in August 1914 in the waters south and southwest of Halifax (Stations 10235, 10236, 10237, 10242); on Brown's Bank (Station 10228); in the Eastern Channel (Station 10227); on the eastern and southern edges of Georges Bank (Stations 10226, 10219), and on the southern edge of the continental shelf south of Marthas Vineyard (Station 10260).

In 1915 swarms of *Limacina balea* were encountered on three occasions, first over the outer edge of the continental shelf south of Shelburne, Nova Scotia, June 23 (Station 10294); off Marthas Vineyard, October 22 (Station 10333) and again in Massachusetts Bay, October 27 (Station 10338), while it occurred, in smaller numbers, at about 50% of the stations in the Gulf.[1]

Although *Limacina balea* is a characteristic member of the Gulf plankton, and though it has now been taken in all parts of the Gulf, it is far less regular in its occurrence than Calanus, Euthemisto, or *Sagitta elegans*. Thus it swarmed on German Bank in August 1912, and in August 1913; but was not found there in August 1914, or in either May, June, or September of 1915, though it occurred only a few miles away (Stations 10270, 10310). At several localities, too, it was present during one cruise in 1915, absent on the next, or *vice versa*, for example, off Monhegan Island (Stations 10303, 10318); off Matinicus (Stations 10276, 10287), and in the northeast corner of the Gulf (Stations 10273, 10287). And neither in 1912, 1914, nor 1915, was it as generally distributed in the Gulf as it was in 1913 (1915, p. 303, fig. 72). In spite of these anomalies, however, there is some evidence that Limacina approaches the western and northern coasts of the Gulf as the summer advances, for in 1915 none were taken in the numerous hauls along the Maine coast until September; and it appeared in summer off Cape Ann (Station 10306) and off Matinicus (Station 10287), where it was lacking in May (Stations 10266, 10276).

We have usually found *Limacina balea* most abundant in hauls from 30–60 meters (1915, p. 305), absent on the surface. But it occurred on the surface at four stations, twice in considerable numbers in 1914 (Stations 10247, 10264); at five in 1915 (Stations 10294, 10295, 10308, 10329, 10333), twice in swarms (Stations 10294, 10333). However, these surface catches were made at night, and it was never found on the surface between sunrise and sunset. Apparently Limacina, like other plankton organisms performs a more or less regular vertical migration, rising toward the surface at night, sinking again at daylight.

The salinities at which Limacina was numerous in 1914 and 1915 range from about 31.06‰ (Station 10295) to at least 35‰ (Stations

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[1] *Limacina balea* was taken at the following stations in 1915: 10269, 10270, 10272, 10273, 10278, 10279, 10287, 10288, 10291, 10294, 10295, 10306, 10307, 10308, 10309, 10310, 10317, 10318, 10320, 10321, 10328, 10329, 10330, 10331, 10332, 10333, 10337, 10338.

10220 and 10261); the temperature from about 5°–6°; to about 16.6° (Station 10264, surface), *i. e.*, it was scarce, or absent both in the coldest and warmest, and in the very freshest and saltest, water; which corroborates the previous records (1915, p. 305). Its rarity in Gulf Stream water (Station 10218), while it was common at other stations on the slope where hydrography and plankton were less purely oceanic (Stations 10220, 10261), indicates that the junction of coast and oceanic waters is its normal southern limit, at least in the upper layers, which agrees with the experience in 1913 (1915, p. 305) as well as with its distribution in other regions; and its absence in the southeastern part of the Gulf, in the Eastern Channel and in the area off Halifax is explicable on this basis, these regions being occupied by unmistakable, though diluted tongues of offshore water (p. 196). Similarly, its absence, or rarity, in the very cold water of the Cabot Current, off Shelburne, certainly suggests that it does not reach the Gulf by that route.

But hydrography offers no apparent explanation for the irregularity and sporadic nature of its occurrence within the Gulf. Hence, if its distribution there be dependent on the physical environment, as is no doubt the case in the last analysis, it probably is neither temperature nor salinity alone which limits the existence of the adult, but a complicated set of interacting phenomena. Possibly too high temperature and salinity may directly prevent its reproduction: it may be food supply which is the limiting factor; or warm or cold ocean currents may act as actual physical barriers to its dispersal.

Limacina helicina being as good an index of Arctic water (Meisenheimer, 1905b; Murray and Hjort, 1912, p. 640) as *L. balea* is for boreal, its occurrences in our waters are of great interest. It has never been found in the Gulf of Maine in summer (1914a, 1915); nor in the western half of the latter at any season. But on our May cruise, in 1915, it occurred at the two stations on the eastern side where salinity (p. 224), temperature (p. 215), and other Arctic organisms (p. 248) gave unmistakable evidence of Cabot Current water (Station 10270, 150–0, and 50–0 meters, two specimens; 10272, 60–0 meters, seven specimens).

We did not find it again in the Gulf; but in June it occurred at two stations off Shelburne, one close to the land (Station 10291, 85–0 meters, five specimens), the other over the continental slope (Station 10295, 500–0 meters, two specimens). In August, 1914, it occurred twice near land, off Halifax (Station 10236, 65–0 meters, two specimens; Station 10237, 75–0 meters, two specimens).

The third characteristic pteropod of northern waters, *Clione lima-*

cina, appears to occupy a rôle intermediate between *Limacina balea* and *L. helicina* in the Gulf, occurring irregularly, usually in small numbers. But though it never attains the faunal prominence there that it does further north, and has been decidedly rare in recent years (1914a, 1915), it is recorded by Wood as swarming in Portland Harbor in May, 1868, when "the water appeared to be alive with them" (Wood, 1869, p. 185). However, such occurrences are certainly exceptional, as is its occasional appearance, in numbers, as far west as New York (De Kay, 1843, p. 6). Whether they are due to invasions by northern water, or to local propagation, is an open question.

The summer records (1914a; 1915) show that Clione may be expected anywhere in the Gulf; and it is no more regular in its occurrence in the eastern than in the western side, contrary to what might be expected of a cold-water organism, and to what is actually the case with *Limacina helicina* (p. 300). But it was distinctly seasonal in 1915, for while it was taken at most of the stations in May, (Stations 10266, 10269, 10270, 10271, 10272, 10276, 10277, 10278, 10279, 10280), it occurred at only about half the June stations (Stations 10281, 10282, 10284, 10286, 10287, 10288, 10293, 10294), and while we have occasional records for July and August (1914a, 1915), it was not taken in September or October, 1915; nor off Massachusetts Bay November or December, 1912 (1914b, p. 404), though it reappeared there in small numbers in January and February, 1913. Our records added to Wood's account, point to spring as its season of greatest abundance in the Gulf.

Clione is one of the most prominent members of the macroplankton of the Arctic Ocean (Meisenheimer, 1905b; Damas and Koefoed, 1907, Paulsen, 1910); and it swarms in the polar waters of the Labrador Current off the east coasts of Newfoundland and Labrador, where I myself found it in great numbers among the floe ice, in the summer of 1900. The apparent correspondence between its seasonal maximum, and the seasonal fluctuations of the Cabot Current in the Gulf of Maine, suggests that its numbers there are recruited from the north. But its distribution within the Gulf does not correspond to the northern water there, as does that of *Limacina helicina* (p. 300), Mertensia (p. 248), or the Arctic Oikopleura. On the contrary, Clione was as numerous in the western as in the eastern part of the Gulf (p. 248) even in May. It was rare in the Cabot Current off southern Nova Scotia in summer (Stations 10233, 10235, 10243, a total of four specimens in 1914: Station 10294, one specimen in 1915).

In reality, as Damas and Kofoed point out (1907, p. 361), *Clione limacina* is not the sure index to Arctic water that many have supposed, for it is quite as abundant in the Atlantic water south, as in the Arctic water north, of Iceland (Paulsen, 1909, p. 42, Murray and Hjort, 1912, p. 107); and is common south of Ireland (Massy, 1909). The true explanation is that though Clione reaches its maximum size, and abundance in Arctic waters, its normal range reaches the northern boreal waters as well. In the Gulf of Maine it is probably endemic in small numbers which may receive additions annually from the north.

Two other species of pteropods were taken in the Gulf of Maine in 1914, a Pneumoderma too young for specific determination (Station 10245); and two specimens of *Limacina inflata* off Cape Cod (Station 10213), the latter no doubt stragglers from the south.

The stations on the continental slope, on Georges Bank, and off Marthas Vineyard, yielded the following tropical pteropods and heteropods (identified by W. F. Clapp): —

	10216, 60–0 meters	10218, 60–0 meters	300–0 meters	400–0 meters	10219, 80–0 meters	10220, 400–0 meters	10261, 400–0 meters
Limacina rangii d'Orb.						4	
Creseis conica Eschscholtz				1			
" *acicula* Rang.				1			
Hyalocylis striata Rang.				1			
Cuvierina columnella Rang.				2			
Diacria trispinosa Lesueur				1			
Carolina tridentata Forskål					1		2
" *longirostris* Lesueur				1			
" *uncinata* Rang.		1					
Peracle reticulata d'Orb.				1			
Corolla calceola Verrill		1		1			
Pterotrachea keraudrenii Souleyet	2						
Firoloida desmarestia Lesueur			1				
Pleurobranchea tarda Verrill			2				

Pelagic Coelenterates. The Medusae, Siphonophorae, and Ctenophorae taken on the cruises of 1914 and 1915 fall into two well-marked geographic groups, Boreal-Arctic, and Tropical. The records for the former for 1914 are given in the following table: —

	10213	10214	10215	10216	10219	10220	10224	10225	10227	10228	10229	10230	10231	10232	10233
HYDROMEDUSAE															
Hybocodon pendula	×														
Lymnorea borealis			×												
Leuckartiara octona															
Catablema vesicaria															
Melicertum campanula															
Staurophora mertensii		×					×								
Mitrocoma cruciata															
Obelia sp.			×		×	×									
Phialidium languidum															
Aequorea tenuis								×							
Aglantha digitale				×		×					×	×	×	×	
SIPHONOPHORES															
Diphyes arctica						×									
Stephanomia cara	×							×							
SCYPHOMEDUSAE															
Cyanea capillata		×	×				×								
Aurelia aurita															
CTENOPHORES															
Mertensia ovum															
Pleurobrachia pileus															
Bolinopsis infundibulum															
Beroe cucumis								×	×	×			×	×	×

	10234	10235	10236	10237	10243	10245	10246	10247	10248	10249	10250	10251	10253	10254	10256
HYDROMEDUSAE															
Hybocodon pendula															
Lymnorea borealis											×				
Leuckartiara octona										×					
Catablema vesicaria			×												
Melicertum campanula									×						
Staurophora mertensii										×					
Mitrocoma cruciata							×				×				
Obelia sp.															
Phialidium languidum						×	×	×	×	×	×	×	×	×	
Aequorea tenuis															
Aglantha digitale			×	×		×	×		×		×				
SIPHONOPHORES															
Diphyes arctica															
Stephanomia cara														×	×
SCYPHOMEDUSAE															
Cyanea capillata															
Aurelia aurita					×										
CTENOPHORES															
Mertensia ovum			×												
Pleurobrachia pileus					×		×		×						
Bolinopsis infundibulum										×	×				
Beroe cucumis	×	×	×	×	×		×		×						

Most of these species have been recorded from the Gulf of Maine, (A. Agassiz, 1865; Bigelow, 1914a, 1914b, 1915). The Grampus records add little to previous knowledge, either systematic or geographic.

Perhaps the most interesting feature of the Grampus collections is the general scarcity of coelenterates at all of the Gulf stations, at any distance from land, except for the following species, *Phialidium languidum*, *Mitrocoma cruciata*, *Aglantha digitale*, and *Pleurobrachia pileus*. The records for these in 1915 are: —

	10270	271	272	276	278	281	282	286	287	288	290	291	293	294
Mitrocoma cruciata	×	×	....	....	×	....	×	×	×	×	×	×	×	....
Phialidium languidum [1]	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Aglantha digitale	×	....	×	×	....	×	....	....	....	....	×	×	....	×
Pleurobrachia pileus	....	×	×	....	....	....	....	....	....	....	×	....	....	....

	10295	301	303	304	306	310	311	317	318	321	323	327	328	329
Mitrocoma cruciata	....	×	×	....	....	....	....	....	....	....	....	....	....	....
Phialidium languidum [1]	....	....	....	×	....	....	....	×	×	....	....	×	×	×
Aglantha digitale	×	....	....	....	×	....	....	....	....	....	....	....	×	....
Pleurobrachia pileus	....	....	×	×	×	×	×	×	....	×	×	×	×	×

The presence or absence of Aurelia and Cyanea is always worth noting, because they are such typically neritic organisms (1914a, Damas, 1909) that their occurrence is a sure index of coast water. Their rarity over the whole offshore parts of the Gulf, and off Nova Scotia, except close to land, in which the records for 1914 and 1915 agree with previous experience is discussed above. Phialidium is less closely restricted to the shore than either Cyanea or Aurelia (p. 251), hence probably is not limited to such shallow water during its fixed stage. However, none of the captures of Phialidium have been far outside the 100 fathom curve; nor more than fifty miles from land, and most of the records are much nearer the shore. On each of the cruises in the Gulf Phialidium was found swarming, but each time in a different place; near Mt. Desert Rock and off the Kennebec river in 1912; off Penobscot Bay in 1913; over the Eastern Basin (Station 10249) in 1914; and in Kittery River, and off Rye in 1915. Our experience has always been that Phialidium is most numerous at or near the surface; and this is well illustrated at Station 10249, where only a few were taken in the 50 meter, none in the 175 meter haul, though it was very numerous on the surface. As yet it has not been found on Georges Bank on the one hand, nor off the south coast of Nova Scotia on the other; and it is probable that the Gulf of Maine is the northern limit to its abundance. The earliest records for Phialidium are in July and it is usually most numerous during August.

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[1] Also abundant in Kittery River and off Rye, N. H., July 23.

The comparative abundance of *Mitrocoma cruciata* in May and June 1915, and its absence during summer and autumn, explains its rarity during the July and August cruises of previous years (p. 304; 1915, p. 316). This agrees with Alexander Agassiz's statement that it is frequently found in Massachusetts Bay during early summer (1865, p. 102). As the table shows, its period of abundance hardly overlaps that of Phialidium.

Staurophora mertensii has been found, in past years, in most parts of the Gulf, (1914a, 1915). But so far as the hauls can be trusted, there has been a steady decrease in its numbers since 1912. Thus Staurophora was taken at many stations in that year, often in swarms: at seven stations, usually in small numbers, in 1913: in 1914 it was found at three stations, only once (Station 10214) in any numbers, although the work was done at about the same time of year; and in 1915, it was taken at four stations, a total of only four specimens. Staurophora has not been taken on Georges Bank, nor south of Cape Cod: but it is recorded from Woods Hole (Hargitt, 1905).

The other neritic Medusae occur so rarely and irregularly in the hauls that I need only note that the Obelia on the northern part of Georges Bank were no doubt associated with the Obelia hydroids found floating there (p. 252, 1915).

Only one oceanic Medusa, *Aglantha digitale*, occurs with any regularity in our waters; and enough records for this species have now been accumulated to show that it may be expected anywhere in the Gulf; though never abundant there. It is also taken in hauls in the zone of mixed water over the continental slope, often in some numbers (1915); but so far has not been recorded from undiluted Gulf Stream water (*e. g.* it occurred at Stations 10220 and 10233, but not at 10218).

The only siphonophore which occurs in any numbers in the Gulf is *Stephanomia cara;* but unfortunately it is so fragile that the specimens captured are usually in the most fragmentary state imaginable. The identification of the records listed (p. 303) depends on the shape of the nectophores and the presence of the oil-globule in the palpons (Fewkes, 1888), no tentilla being intact.

The captures of *Diphyes arctica* at Station 10220 in 1914, and again off Shelburne (Station 10295) in 1915, are of interest because this siphonophore has not been recorded previously from American waters. In these specimens all the superior nectophores are in such good condition and agree so well both with Chun's (1897) figures and with the Behring Sea series which I have studied (1913) that the identification was easy. At the moment the geographic status of *D. arctia* is doubtful, for though it was formerly thought to be a typical Arctic form (1911, Chun, 1897, Romer, 1901), it has recently been captured in deep hauls by the Gauss off Cape Verde (Moser, 1915). Certainly, however, it does not belong to the surface waters of the Gulf Stream; and so far as American coast waters are concerned it can safely be ascribed a northern origin. The local swarming of *Pleurobrachia pileus* has already been noted (p. 242); as has also the occurrence of the Arctic ctenophore *Mertensia ovum* in the Gulf of Maine in May and off Shelburne in June, 1915 (Stations 10271, 10272, 10291, 10294, p. 249).

The following warm-water coelenterates were taken in the inner edge of the Gulf Stream off Georges Bank, in July 1914 (Station 10218).

Medusae	60–0 meters	300–0 meters	Siphonophores	60–0 meters	300–0 meters
Stomotoca pterophylla	×	×	*Hippopodius hippopus*		×
Toxorchis kellneri	×	×	*Diphyes spiralis*	×	
Laodicea cruciata	×	×	" *appendiculata*	×	
Rhopalonema funerarium		×	" *bojani*		×
" *velatum*	×	×	*Diphyopsis dispar*	×	×
Liriope scutigera	×		" *mitra*	×	×
" *tetraphylla*		×	*Agalma elegans*	×	×
Aglaura hemistoma	×	×	*Anthophysa formosa*	×	
Nausithoe punctata	×		*Physalia physalis*	×	

Physalia was also seen floating near Stations 10258 and 10262, as well as over the outer part of the shelf south of Marthas Vineyard in 1914; near Brown's Bank (Station 10296) and in the Eastern Basin of the Gulf (Station 10288) in 1915 (p. 246).

These siphonophores, and most of the Medusae, are oceanic species which might be expected anywhere in the Gulf Stream or the subtropical Atlantic. But two of the medusae, Stomotoca and Toxorchis, are neritic West Indian forms, not previously known north of Florida. Their occurrence at Station 10218 exemplifies the efficacy of the Gulf Stream current as a carrier of tropical organisms. Laodicea is likewise neritic, but ranges at least as far north and east along the coast as Woods Hole.

Finally, a single specimen of *Diphyes truncata*, from Station 10220 is worth noting, because this species was not known from American waters, though it is probably cosmopolitan (1913, Moser, 1915).

Quantitative Distribution of Plankton, 1914, 1915.

Only on the supposition that the plankton is uniform horizontally, over considerable areas, could a satisfactory quantitative survey be expected from vertical hauls as far apart as those of the GRAMPUS; and this is far from true of the plankton of the Gulf, organisms of one sort or another often occurring in streaks, or swarms, for example diatoms in the spring of 1913 (1914b), fish eggs (p. 257), Sagittae (p. 294), and pteropods (p. 298).

However, this seems to be less often the case with copepods, which are, on the whole, the most important constituent of the Gulf plankton; and since the quantitative hauls show a certain consistency from year to year and from season to season, while nothing whatever was known up to 1912 as to the amount of plankton present in the Gulf, the general results are worth recording.

The quantitative distribution of plankton may be measured in several ways, the most obvious unit being the total bulk of plankton present from surface to bottom, usually in terms of a column one square meter in cross section. (The area of the mouth of the HENSEN quantitative net used in 1914 is .1 square meter: in 1915 we used a MICHAEL SARS net .5 m. in diameter, *i. e.*, with mouth area of approximately .2 square m.). Volume, it is true is a very rough measure (Steuer, 1910), different types of plankton packing down more or less densely; but it still remains the most convenient index to the comparative abundance of the plankton as a whole, as distinguished from its various individual components.

The volumes of the quantitative hauls of 1914 (measured as in previous years, 1914a, 1915), are as follows: —

Station	Depth meters	Vol. cc.[1] per square meter	Station	Depth meters	Vol. cc. per square meter
10213	110–0	210	10234	95–0	25
10214	175–0	120	10236	70–0	10
10215	70–0	60	10237	75–0	5
10216	70–0	30	10243	55–0	100
10218	500–0	50	10244	50–0	15
10223	75–0	170	10245	110–0	60
10224	55–0	240	10246	190–0	200
10225	260–0	30	10247	30–0	10
10226	85–0	200	10248	190–0	100
10227	220–0	50	10249	220–0	105
10229	100–0	170	10250	145–0	350
10230	50–0	140	10253	140–0	60
10231	50–0	20	10254	260–0	200
10232	140–0	50	10255	175–0	70

The stations may be grouped in three classes, rich, with 100 cc. or more; intermediate, with 30 to 100 cc.; and barren, with less than 30 cc. The horizontal hauls at Stations 10228 and 10258, where no quantitative hauls were made, put them in the "rich" class; while the same test classes, Stations 10233, 10251 and 10260 as intermediate, 10220, 10235 and 10261 as barren. On this basis (Fig. 91) the plankton under each square meter of the sea surface was rich over a belt running from off the mouth of the Bay of Fundy southwest to Massachusetts Bay and the southwestern basin of the Gulf; probably also covering Nantucket Shoals and following the coast as far west as Marthas Vineyard, with other "rich" areas on the northeastern part of Georges Bank, in the Northern Channel, on Brown's Bank, and off Cape Sable. On the other hand it was very scanty (30 cc. or less) along the southern slope of Georges Bank, in the northeastern and southeastern corners of the Gulf; and generally south and southwest of Halifax. In the northwestern, central, and eastern parts of the Gulf as a whole, on the northwestern part of Georges Bank, in the Eastern Channel, and over the whole breadth of the continental shelf off Shelburne, Nova Scotia, plankton volumes were intermediate between these extremes.

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[1] No attention is paid here to the coefficient of filtration of the net, which being the same for all hauls, does not effect their comparative value.

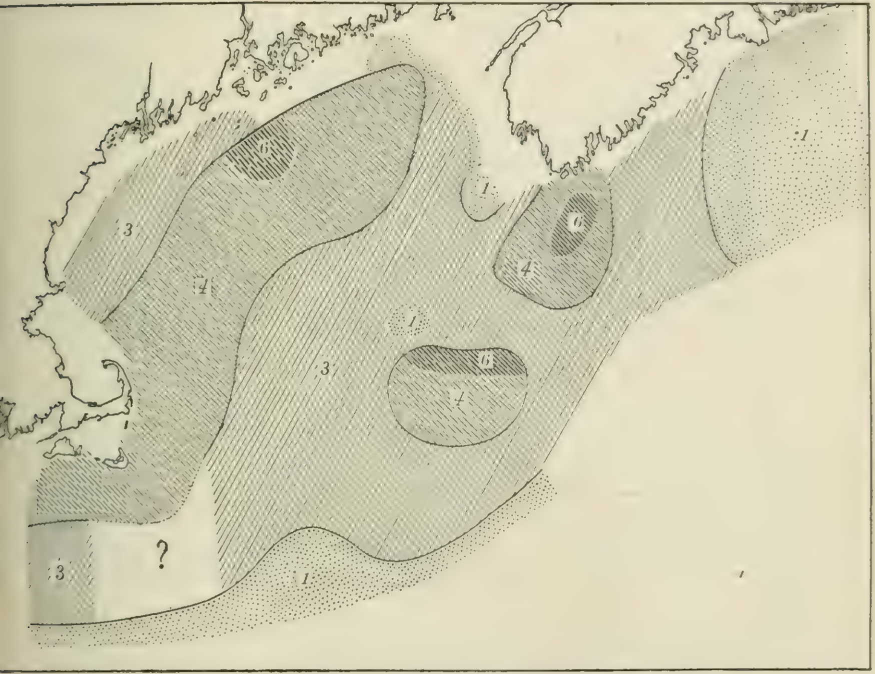

FIG. 91.— Volumes of plankton per square meter of sea area, July–August, 1914.

6, very rich,	170 + cc.	per square meter.
4, rich,	100 + cc.	"
3, intermediate,	30 – 100cc.	"
1, scanty	30 – cc..	"

The volume of plankton, however, is no index to its regional density, which is after all the most important question before us, because the amount of water filtered varies with the depth at various stations; a better criterion is the volume per cubic meter.

Volume of Plankton per Cubic Meter, 1914.

Station	Vol. cc. per cubic meter	Station	Vol. cc. per cubic meter
10213	1.9	10234	.26
10214	.68	10236	.14
10215	.85	10237	<.1
10216	.43	10243	1.8
10218	.1	10244	.3
10223	2.2	10245	.54
10224	4.3	10246	1.
10225	.11	10247	.33
10226	2.3	10248	.52
10227	.22	10249	.48
10229	1.7	10250	2.4
10230	2.8	10253	.42
10231	.4	10254	.77
10232	.35	10255	.4

Horizontal hauls class the stations where no quantitative hauls were made, as follows: — rich, Stations 10229, 10258: intermediate, 10233, 10235, 10245: barren 10220, 10251, 10260, 10261. According to the table Stations 10248 and 10249 are intermediate; but they are treated here as rich because the horizontal hauls show that the density of the plankton was much greater than the quantitative hauls suggest.

In the western part of the Gulf, on the northeastern corner of Georges Bank where it is high (.6+), and off the southern and southeastern coasts of Nova Scotia, volume per cubic meter, *i. e.*, density, corresponds fairly well with the volumes per square meter. But density was comparatively greater than volume on the western part of the Bank, and in the northeastern corner of the Gulf, while in the southeastern part, the reverse was true. The barren area (.3— cc. per cu. m.) was continuous with the sparse plankton of the deep water over the continental slope (Fig. 92). The plankton was densest on the northeastern part of Georges Bank, off Cape Sable, and locally off Penobscot Bay.

Were the plankton uniformly distributed vertically, the foregoing calculation would be satisfactory; but our previous experiences in the

Gulf of Maine have shown that it is usually more or less stratified. In 1913 the greater part of the plankton was condensed in the upper 100 meters or so; and while no such general rule can be laid down for 1914, because sometimes the deeper haul (Stations 10215, 10246, 10248, 10254), sometimes the shallower (Stations 10214, 10233, 10249,) yielded the largest catch when two subsurface hauls were made at different levels, usually one was much larger than the other, as illustrated by the following table of catches in the horizontal hauls, reduced to a column 1 square meter in cross section. Duration of hauls, ½ hour. The depth is the level at which the major part of each haul was made.

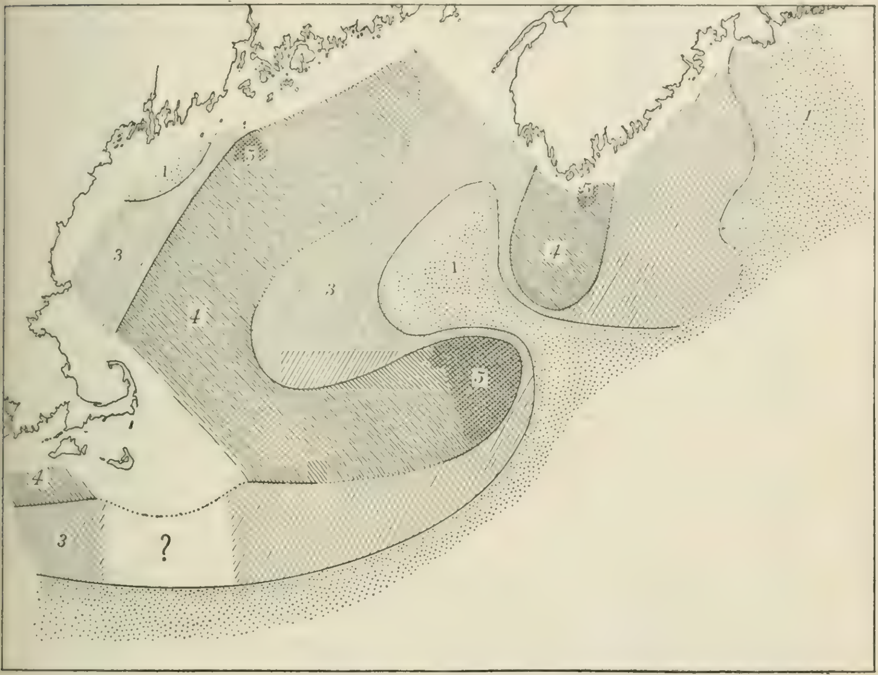

FIG. 92.— Plankton volume per cubic meter, July–August, 1914.

5, very rich	**1 + cc.**	**per cubic meter**
4, rich	**.6 + cc.**	**“**
3, Intermediate	**.3 – .6 cc.**	**“**
1, scanty	**.3 – cc.**	**“**

Station	Depth meters	Volume cc.	Station	Depth meters	Volume cc.
10213	70	1000	10235	80	125
10214	30	3550	10236	50	250
	150	250	10237	60	125
10215	30	150	10242	0	1500
	60	375	10243	40	1250
10216	50	125	10245	100	125
10219	60	600	10246	50	150
10223	50	375		150	1000
10224	40	2500	10248	50	150
10225	60	150		150	1250
	240	125	10249	50	2180
10226	60	2500		175	500
10227	180	125	10250	120	125
10228	0	1250	10251	100	125
10229	80	3750	10253	80	375
10230	40	2500	10254	75	150
10231	0	337		225	625
10232	50	125	10255	150	125
	100	125	10256	130	375
10233	0	150	10258	25	1000
	100	610	10260	60	150
	300	250		120	125
10234	75	125	10261	400	125

As a whole the water was richer in plankton above 100 meters than below that depth, the mean volume of all the catches taken above 100 meters (909 ccm.) being almost three times the mean of all the deeper hauls (350 ccm.); while it was only above 100 meters that exceptionally large catches (2000 ccm. or more) were taken. Consequently, the volumes per cubic centimeter as calculated from the quantitative hauls must be used with discrimination. They represent the actual density fairly well at stations where no stratification is apparent from the horizontal hauls (*e. g.* Stations 10225, 10232); and approximate the truth in shallow waters, particularly where mixed vertically by tidal currents. But they greatly understate the actual maximum density in deep water where the plankton is stratified, making such regions appear much less prolific, as feeding grounds for pelagic fishes than they actually are, while crediting to their barren layers a richness which they do not possess.

Some information as to the seasonal fluctuations in the amount of plankton present in the Gulf is afforded by the work done in 1915. In May of that year the volume of plankton, both per square meter (Fig. 93) and per cubic meter, was greatest in the east and west sides of the Gulf. But though the rich area extended right across the Gulf it[1] was indented on the north by less prolific water; and the zone along the northern coast, *i. e.*, just where the diatom swarm was at its maximum, was very barren of large organisms, as illustrated by the following table of volumes per square, and per cubic meter for that year. These, however, are not directly comparable with the data for 1914, since a different net was used.

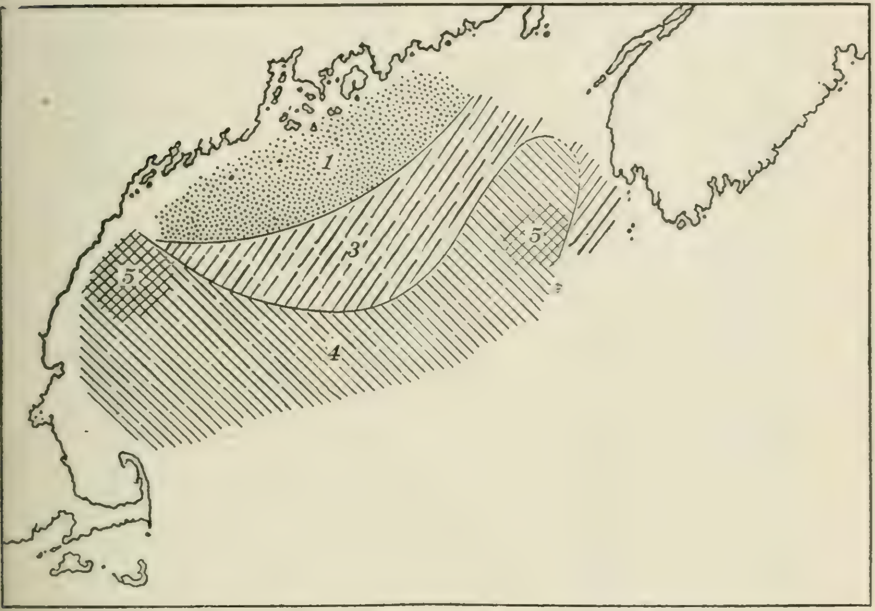

FIG. 93.— Plankton per square meter of sea area, May 1915.

5, very rich	300 + cc.
4, rich	100 + cc.
3, intermediate	30 − 100 cc.
1, scanty	30 − cc.

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[1] Its continuity depends on the richness of the horizontal surface haul at Station 10268.

Station	Vol. per sq. meter	Vol. per cu. meter	Station	Vol. per sq. meter	Vol. per cu. meter
	cc.	cc.		cc.	cc.
10266	270	2.1	10309	425	2.12
10267	250	1.	10310	225	1.18
10269	70	.4	10311	45	.7
10270	370	2.	10313	50	.7
10271	75	1.	10315	50	.6
10272	170	2.1	10316	12.5	.2
10275	20	.4	10318	25.	.3
10276	10	.1	10319	30.	.85
10278	325	2.1	10320	50.	.7
10279	250+	3.8	10321	30.	.75
10281	10	.1	10323	37.5	.47
10282	50	.2	10324	150	1.
10283	100	.55	10325	225	1.3
10284	15	.18	10326	150	.1
10286	15	.18	10327	20	.33
10287	50	.7	10328	30	.5
10288	150	.7	10329	100	1.6
10290	40	.6	10331	75	2.5
10291	125	1.7	10332	100	2.
10294	100	.6	10333	100	1.3
10298	50	.4	10336	125	2.5
10299	200	1.	10337	100	1.6
10304	275	1.37	10338	250	3.1
10306	110	.78	10339	75	1.
10307	165	.7			

Average 115 1.1

From May to June the amount of macroplankton present increased off Matinicus and over the northern part of the Eastern Basin, decreased in the Western Basin, a change resulting in much the same conditions as in August 1914. But in September, as in May, plankton was most abundant in the sink north of Cape Ann, and again over the Eastern Basin; with a band of decidedly barren water all along the coast of Maine from Cape Elizabeth to Grand Manan Channel. The average volume of plankton, both per square and per cubic meter was greatest in May (181; and 1.5 cc. respectively). least in June (80 cc. and .4 cc.), with the September volumes intermediate (145 cc.; and about 1 cc.); and in that month the richest haul was made (425 cc.

per square meter at Station 10309). But not enough hauls were made in any month, in 1915, for these averages to be more than a general index to abundance.

Number of Copepods. The work during 1914 strengthens the view that copepods are the only important members of the macroplankton of which the quantitative hauls yield an approximately complete catch (1914a, 1915), for comparatively few Sagittae, amphipods or schizopods were taken in the Hensen net even at stations where they were very abundant (*e. g.* the Sagitta swarm at Station 10224). For this reason the copepods alone are treated numerically here.

The numbers of copepods per square, and per cubic meter, disregarding the coefficient of filtration of the net, is given in the following table for 1914.

Station	Copepods per sq. meter	Copepods per cu. meter	Large Calanus per sq. meter	Large Calanus per cu. meter
10213	189500	1722	90000	818
10214	53500	306	50000	285
10215	71000	1014	6450	92
10216	11000	157	2450	35
10218	6500	13	5000	10
10223	74000	986	35000	465
10224	6000	109	600	10
10225	15000	58	6000	57
10226	81500	959	77000	900
10227	25000	114	8500	38
10229	227000	2270	32500	190
10230	59000	1180	22000	440
10231	11000	220	5500	110
10232	29500	211	18000	128
10234	10500	110	3500	36
10237	4000	53	3750	50
10243	167000	3036	55660	1012
10244	38500	770	1920	38
10245	17500	159	5800	52
10246	71000	373	50000	260
10248	51500	270	25000	250
10249	49500	225	45000	204
10250	99500	686	25000	172
10253	64500	460	41500	296
10254	94000	361	90000	345
10255	63500	363	45000	257

Copepods were most numerous, per square meter (70,000) over a V-shaped region, with one arm extending from Cape Cod toward Penobscot Bay, the other to the northern part of Georges Bank; off Cape Sable; in the extreme northeast corner of the basin of the Gulf; and south of Marthas Vineyard (Fig. 94), with maxima off Cape Cod, off Cape Sable, and in the Northern Channel (Stations 10213, 10243, 10229). But there were very few copepods in the extreme northeastern corner of the Gulf; in the oceanic water south of Georges Bank; in the Eastern Channel and southeastern part of the Gulf; or in the waters southwest of Halifax; and distribution of copepods, on the basis of numbers per cubic meter was practically

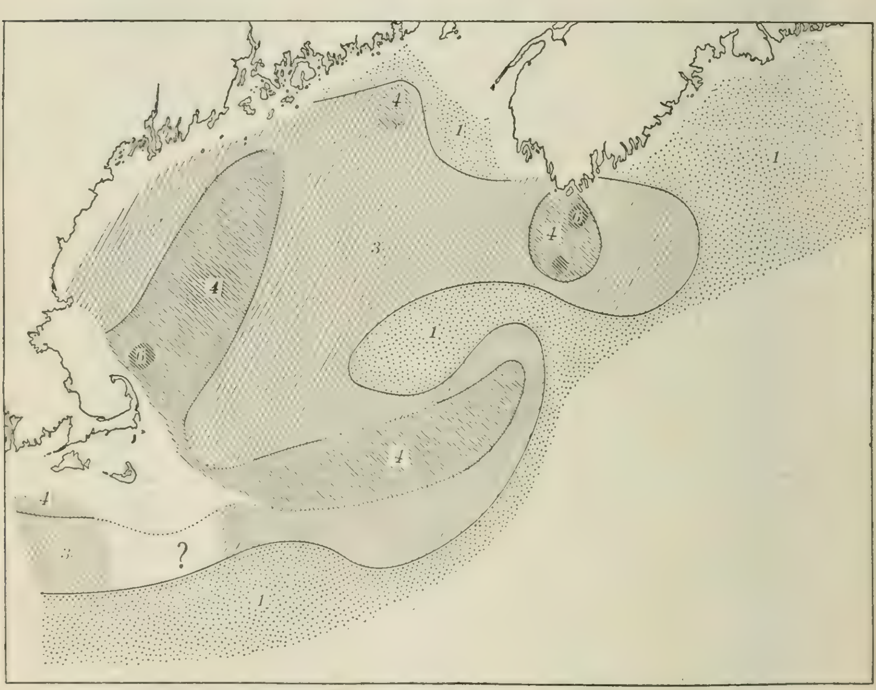

Fig. 94.— Copepods, per square meter of sea area, July–August 1914.

6, very rich	150, 000 +
4, rich	70,000–150,000
3, intermediate	20,000–70,000
1, scanty	less than 20,000

the same (Fig. 95), except that the region northwest of Cape Cod was relatively less productive.

The hauls for the past three years show that copepods must be by far the most important summer food for pelagic fishes in the Gulf of Maine. But the number of these animals as a whole is not a fair index to the fertility of different regions as feeding grounds, because

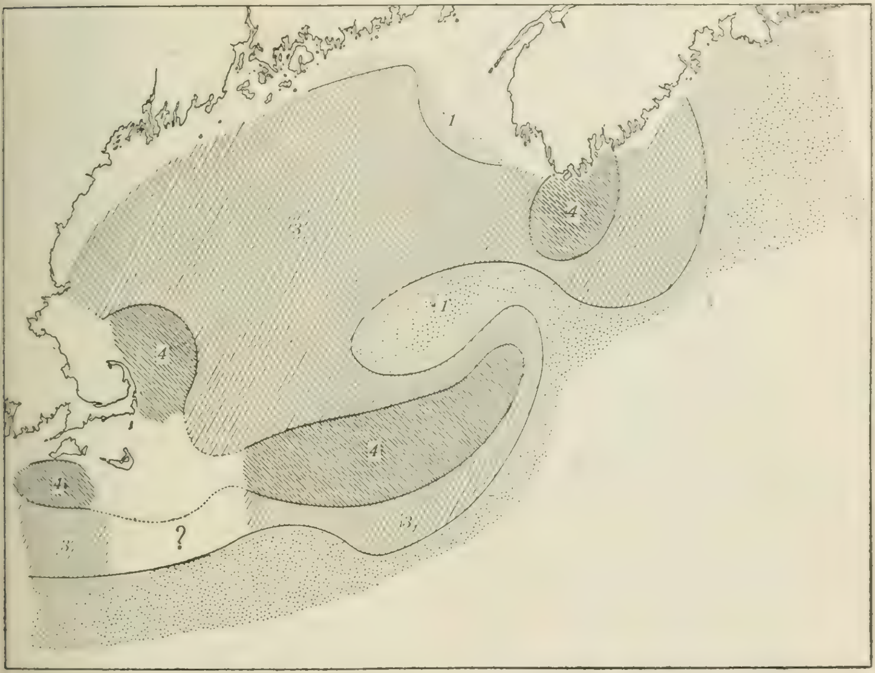

FIG. 95.— Copepods per cubic meter, July–August 1914.

4, rich	900 +
3, intermediate	200–900
1, scanty	less than 200

of the great difference in size between different species; one large Euchaeta or adult Calanus, for example, being equivalent to many young Calanus, Pseudocalanus or Temora, (Farran, 1911). Large Calanus were abundant (30,000+) per square meter over the whole western and southwestern parts of the Gulf, extending northeastward to Station 10246 on the one hand, and probably around Cape Cod to connect with the "rich" water off Marthas Vineyard (Station 10258) on the other (Fig. 96); and there was a second "rich" area over the northeastern part of Georges Bank, a third off Cape Sable. On the other hand the northeastern, eastern, and southeastern parts of the Gulf, including the Eastern Channel, the extreme northern edge of Georges Bank, Brown's Bank, the outer part of the continental shelf south and southwest of Halifax, and the oceanic water on the continental slope were very barren.

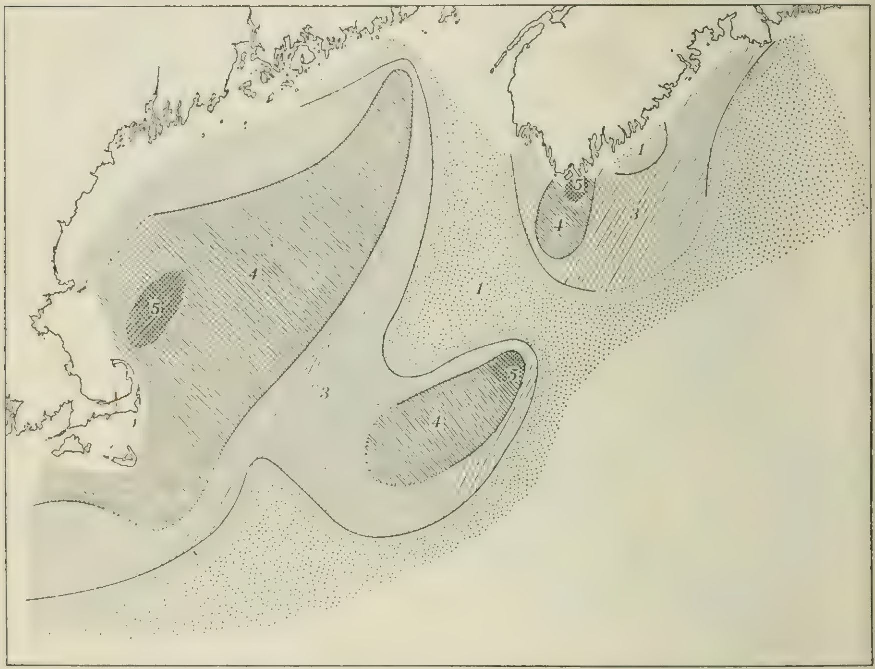

Fig. 96.— Large Calanus per square meter of sea area, July–August, 1914.

5, very rich	50,000 +
4, rich	30,000–50,000
3, intermediate	10,000–30,000
1, scanty	10,000 –

The numbers of copepods as a whole, and of large Calanus, per square meter, in 1915 is listed in the following table: —

Station	Copepods per square meter	Large Calanus per square meter	Station	Copepods per square meter	Large Calanus per square meter
10266	511000	8000	10307	104000	94000
10267	50000	19500	10309	173000	162000
10269	48000	9500	10310	114500	77000
10270	411500	95500	10311	41000	500
10271	11050	750	10313	67000	6500
10272	55000	12000	10315	47000	4500
10275	1000	500	10316	159000	250
10277	7500	1000	10318	14750	3250
10278	175000	56000	10319	66500	6000
10279	189000	38000	10320	42500	205000
10282	10000	8500	10321	45500	1000
10283	21000	12000	10323	77000	22000
10284	2500	1000	10324	112500	40000
10286	11500	3000	10325	158500	65500
10287	35000	9000	10326	86000	39000
10288	55500	20000	10327	30750	500
10290	21500	500	10328	57000	9500
10291	15500	2000	10329	49000	9500
10293	20000	5000	10331	234000	500
10294	65500	13000	10332	319500	7000
10296	9500	8500	10333	204000	6000
10298	11000	5500	10336	205000	44000
10299	43000	39500	10338	244500	97000
10304	234500	40000	10339	50500	5000
10306	51500	34000			

The copepod population of the Gulf for May differs from that of midsummer chiefly in greater local variation, the rich regions being richer, the barren ones even more barren. Thus, the range, was from 1000–500,000 per square meter in May; from 17000–189000 in July and August 1913; 27000–123000 in August 1914. Probably this is a regular seasonal phenomenon, for in 1915 local differences were much smaller in autumn, the number of copepods decreasing in the rich, increasing in the barren portions of the Gulf during the summer. Thus the extraordinarily dense copepod population of the waters off Cape Ann dwindled from 500,000 per square meter early in May, to about 50,000 at the end of August, rising again to 112,000 in October. The swarm over the eastern part of the Eastern Basin underwent a similar change, diminishing from about 400,000 per square meter in May (Station 10270) to about 114,000 in September (Station 10310).

On the other hand, copepods increased on German Bank from 11,000 in May to 21,000 in June, and 41,000 in September; in the western part of the Eastern Basin from 48,000 in May to 173,000 in September; in the Western Basin from 50,000 in May to 104,000 in September; near Mt. Desert Island, from only 1,000 in May to 57,000 in October; off Cape Elizabeth from 7,500 in May to 86,000 in October.

These data point to the waters off Cape Ann and Cape Cod in the west, and off Cape Sable in the east; and to the northern part of Georges Bank, as the richest parts of the Gulf; both for copepods as a whole and for large Calanus (p. 315). But this does not fairly represent the comparative value of our waters as feeding grounds for pelagic fishes, because it neglects two important groups, amphipods and schizopods, which are not adequately represented in the quantitative hauls. Neither of these were of much faunal importance in the Gulf proper (p. 283); but the presence of large numbers of very large amphipods in the waters over the shelf south and southwest of Halifax; and of swarms of schizopods on Brown's Bank and at Station 10233 (p. 283) shows that these localities were more fertile feeding grounds than the small volume of plankton and numbers of copepods would indicate.

Annual Variation in Amount of Plankton. The volume of plankton, and number of copepods per square meter for corresponding localities in the Gulf for August–September 1913–1915, was as follows: —

Locality	Stations			cc. per sq. meter		Copepods per sq. meter		
	1913	1914	1915	1913	1914	1913	1914	1915
Off Cape Ann	10087	10253	10306	180	60	50500	64500	51500
Western Basin	10089	10254	10307	80	200	31000	94000	104000
Near Cashe's Ledge	10090	10255		120	70	43500	63500	
Eastern Basin, west side,	10092	10249	10309	160	105	96500	49500	173000
German Bank	10095	10244	10311	60	15	31500	38500	41000
Off Lurcher Shoal	10096	10245	10315	120	60	70000	17500	47000
North east corner of Basin	10097	10246			200	87000	71000	
Off Petit Menan I.	10098	10247		70	10	40000	few	
Off Mt. Desert Rock	10100	10248		220	100	123500	51500	
Off Matinicus Rock	10101	10250		100	350	75000	99500	
Average				123	117	63772	61055	

This table shows that local differences were considerable from year to year, both in volume and in number of copepods; for example, the latter were three times as numerous in the Western Basin in 1914 as in 1913, while at other localities the reverse was true, the counts made off Lurcher's Shoal in 1913 being four times as large as those of 1914. As a whole, copepods were more numerous in the western half of the Gulf (Stations 10250, 10253, 10254, 10255) in 1914, in the eastern half in 1913. Plankton volumes were greatest in 1913, at all but two stations. But the fact that the averages, both of copepods and plankton volumes, differ but little, suggests that these local differences do not indicate any general change in the amount of plankton present in the Gulf from 1913 to 1915; though this is apparently an increase from 1912 (1915).

Microplankton.

The records are of interest chiefly as illustrating the general characters of the microplankton over the whole breadth of the continental shelf east of Cape Cod, instead of for the Gulf of Maine only, as in previous years (1914a, 1915), and for the information they afford as to seasonal variations in the Gulf.

During the summer of 1914, diatom plankton was encountered at three widely separated localities (Fig. 97) viz., off Marthas Vineyard (Station 10258); on the northern edge of Georges Bank (Station 10224); and near land off Penobscot Bay (Station 10250). These hauls were as far apart in composition as they were geographically, the former consisting of Rhizosolenia (chiefly *R. hebetata semispina*) [1]; the Georges Bank (Station 10224) haul chiefly of *Guinardia flaccida*, with smaller numbers of Rhizosolenia; while the microplankton off Penobscot Bay was mainly Chaetoceras, with smaller numbers of Rhizosolenia and Thalassiosira. At all these stations there were a few Ceratium among the diatoms.

Mixed plankton (diatom and Ceratium) occupied the outer part of the shelf south of Marthas Vineyard and the southern edge of Georges Bank, and the coastal zone in the northeastern corner of the Gulf, both off Maine and Nova Scotia, the three diatom swarms thus influencing the plankton over considerable areas (Fig. 97).

At Stations 10253 and 10254, off Cape Ann, the plankton consisted chiefly of an acantharian radiolarian, Acanthometron, and it reappeared in large numbers off southern Nova Scotia and locally in the center of the Gulf in 1915 (Stations 10309, 10313).

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[1] For an account of the marine diatoms of northern waters, see Gran, 1908.

Elsewhere in the coast water, as well as over the continental slope off Nova Scotia a typical "Ceratium" plankton prevailed (Fig. 97). But the very scanty catches at the three oceanic stations further west (Stations 10218, 10220, 10261) were characterized by the presence of the tropical Alga, Trichodesmium.

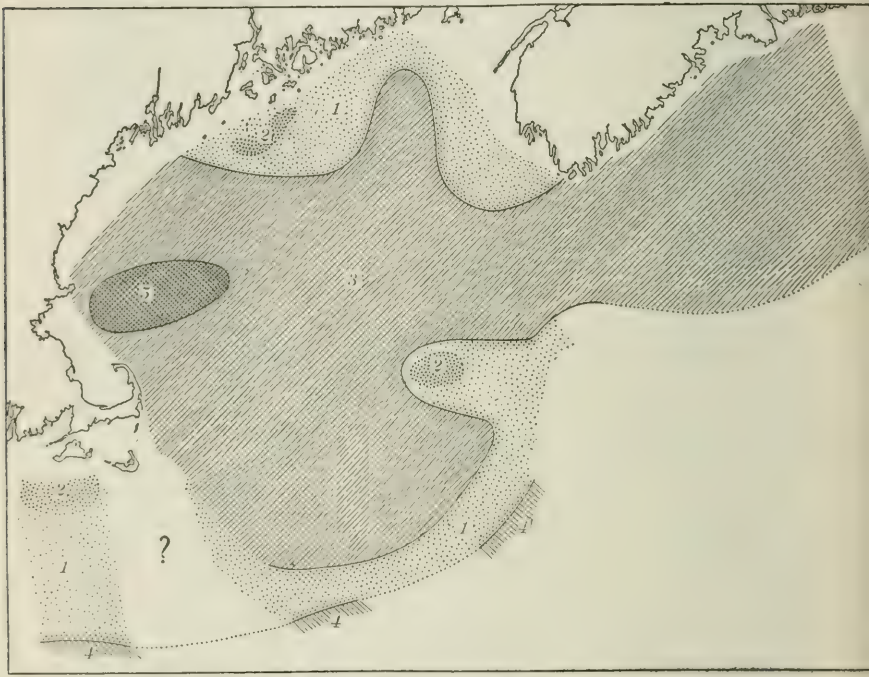

Fig. 97.— Microplankton types, July–August 1914.
3, Ceratium plankton
1, Mixed Ceratium and diatom
2, Diatom
5, Radiolarian
4, Tropical, characterized by Trichodesmium

In 1914, as in 1913, the Ceratium plankton consisted chiefly of two species of Ceratium, *C. tripos* and *longipes* (Paulsen, 1908). In July the latter was much the more numerous of the two in the Gulf, and off southern Nova Scotia (Stations 10229–10243), while *C. tripos* was predominant off the southeastern slope of Georges Bank (Station 10220), and in the coast waters off Marthas Vineyard. In August, however, these proportions were reversed in the central and western parts of the Gulf, as is illustrated by the following table of the two, in samples from representative stations.

Station	C. longipes	C. tripos	Station	C. longipes	C. tripos
10213	50	1	10245	105	2
10216	38	14	10246	62	4
10223	21	1	10248	29	1
10225	9	4	10249	13	47
10227	34	1	10250	32	2
10229	21	1	10251	115	1
10230	60	0	10253	2	10
10233	42	3	10254	4	50
10234	51	0	10255	0	50
10235	63	0	10256	5	76
10236	45	0	10258	1	11
10237	69	4	10264	1	23
10242	91	1			

A third species of Ceratium, *C. arctica*, belonging to frigid waters as its name implies (Murray & Hjort, 1912; Paulsen, 1908; Jørgensen, 1911; Gran, 1902), occurred in small numbers off Nova Scotia (Stations 10230, 10231, 10233, 10236, 10237, 10242; Shelburne Harbor) and at one Station (10248) in the northeast corner of the Gulf of Maine. *C. arctica* has not been recorded previously from the Gulf, so far as I am aware. But it is apparently a characteristic member of the spring plankton of the north Atlantic, for in April, 1910, Jørgensen, on a run from Scotland to Chesapeake Bay, found it regularly from Lat. 48° 50′ N., Long. 35° W., to the neighborhood of the American coast, where it was replaced by *C. longipes*.

Ceratium fusus was as widespread in the Gulf of Maine in 1914 as in 1913, occurring in small numbers at most of the stations. It likewise appeared in the hauls on Georges Bank, Brown's Bank, off Nova Scotia, off Marthas Vineyard, and over the continental slope, (Stations 10214–10216, 10218–10223; 10228, 10229, 10232–10234; 10237, 10242–10245; 10248–10254; 10256, 10259, 10260, 10264).

The oceanic species *C. macroceras*, appeared in small numbers outside the continental slope at our oceanic Stations (10218, 10220, 10261), and in the coastal waters off Marthas Vineyard (Stations 10258–10260). But it has not been detected in the tow over the slope south of Cape Sable (Station 10233), or anywhere on Georges Bank, in the Gulf of Maine, or on the continental shelf south of Nova Scotia, which supports the thesis that it is distinctively a warm water species off this coast.

Though no quantitative hauls were made for microplankton, the horizontal hauls give a rough index to its abundance, when this varies as greatly, from place to place, as it does in our coastal waters in summer. Microplankton was very scanty indeed along the southern edge of the continental shelf, over the slope, in the southeast corner of the Gulf of Maine, (Station 10225); the Eastern Channel, and on Brown's Bank (Stations 10227, 10228). The Nova Scotian waters (Stations 10229–10237) were, if possible, even more barren, a half-hour's haul usually yielding a mere trace. On the other hand the hauls off Lurcher Shoal (Station 10245); off Mt. Desert (10248); off Penobscot Bay (10250); off Cape Ann (10253) and near Marthas Vineyard (10258) were very productive; for example, the volume of the catch of the no. 20 net, 24 ccm. in diameter, towing one half hour, was 40 cc. at Station 10245; 25 cc. at Station 10248; 75 cc. at Station 10250; 80 cc. at Station 10253, 35 cc. at Station 10258. Elsewhere in the Gulf of Maine (Stations 10213–10215, 10246, 10247, 10249, 10254–10256), the volumes of the catches ranged from about 5–10 cc.

The data for 1915 are chiefly valuable as outlining the seasonal fluctuations in the two most important groups, diatoms and Ceratium. In the western part of the Gulf, diatoms swarm in early spring (1914b) when they fill the water almost to the exclusion of other plankton, just as is the case in the Irish Sea (Herdman and Ridell, 1911), in the Skagerak and in the North Sea (Gran, 1915), though it is not known whether the swarm then extends to the eastern shore of the Gulf. In May, 1915, diatoms were still swarming over a triangular area in the central part of the Gulf extending from Cape Elizabeth to the Grand Manan Channel, (Fig. 98), and from the coast of Maine south at least as far as Cashes Ledge. But they had already been replaced by Ceratium off Massachusetts Bay, while Ceratium likewise occupied the waters over the coast bank west of Nova Scotia.

Even the most cursory examination of the diatom swarm of May shows that different genera predominated in different localities. Along the shore of the Gulf (Stations 10275, 10276, 10277), the nets yielded almost pure catches of *Thalassiosira gravida* and *Th. nordenskioldi* as was the case in April 1913 (1914b, p. 405), with smaller numbers of the spirally coiled *Chaetoceras debile* intermingled with the long rod-like *Thalassiothrix longissima*, and an occasional Coscinodiscus. But both Thalassiosira and *Chaetoceras debile* were lacking in the central part of the Gulf, being replaced there by other species of Chaetoceras, especially *C. densum* and *C. boreale*, while the diatom component of the mixed plankton in the eastern side of the Gulf was chiefly *Rhizosolenia semispina* and Chaetoceras. By the middle of June (Fig. 99) pure diatom plankton had dwindled to a small area off Mt. Desert (Station 10285), *i. e.* was no more extensive than in the preceding August (p. 322, Fig. 97). Diatoms had now practically disappeared from the southwestern and central parts of the Gulf (Stations 10298, 10299), where they had constituted the bulk of the plankton a month earlier, while *Thalassiosira gravida*, *T. norden-*

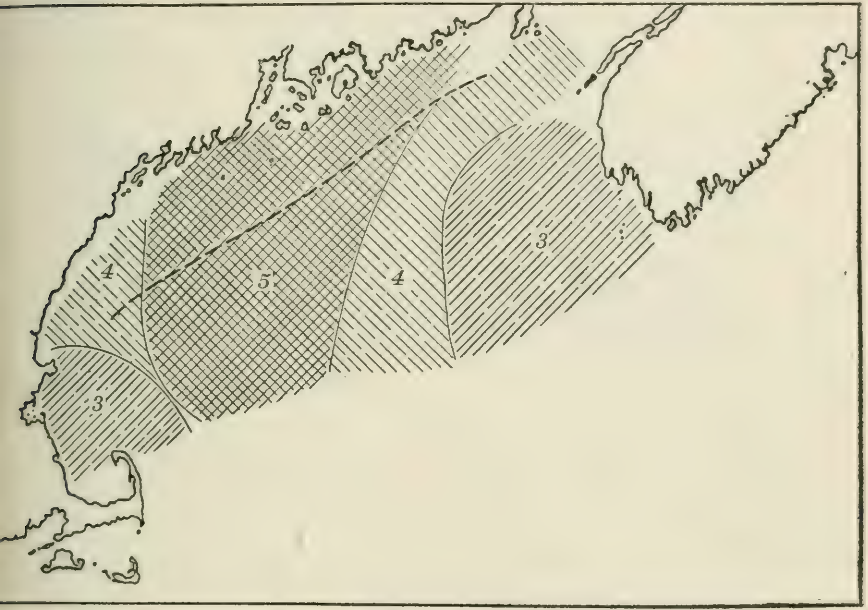

Fig. 98.— Microplankton types, May 1915.
5, Diatom
3, Ceratium
4, Mixed diatom and Ceratium
------, offshore limit to Thalassiosira

skioldi, and *Chaetoceras debile* were restricted to a narrow coastal zone (Fig. 99).[1]

Diatoms diminished still more during the summer, till by September there was no longer any pure diatom plankton at any of the stations; while even mixed plankton was limited to a narrow belt from off Penobscot Bay, to the mouth of the Bay of Fundy (Fig. 100), and to the mouth of Massachusetts Bay where Skelatonema was the predominant genus. Thalassiosira had practically vanished, except for an occasional example at one Station (10317), its place being taken off the coast of Maine by various species of Chaetoceras and Rhizosolenia.

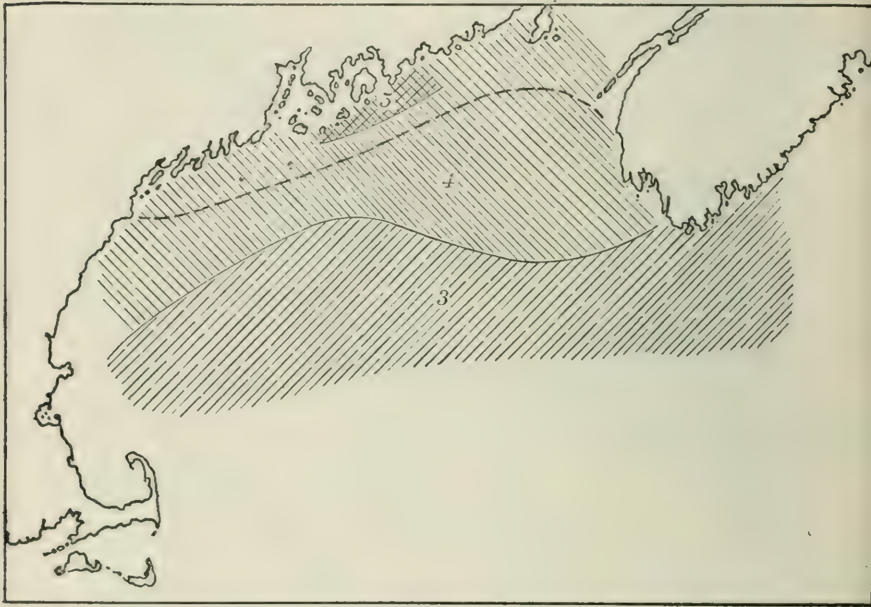

Fig. 99.— Microplankton types, June 1915.
5, Diatom
3, Ceratium
4, Mixed diatom and Ceratium
------, offshore limit to Thalassiosira

In the Gulf the seasonal history of Ceratium is the reverse of that of diatoms, just as in the waters off northwestern Europe (Gran, 1915). When the diatom swarm is at its height in April, Ceratium plays only a subordinate rôle in the plankton of the Gulf (1914b). But by May the waters on the two sides of the Gulf were occupied by Ceratium plankton (Fig. 98); and in June Ceratium had not only replaced the diatoms right across the southern half of the Gulf, from west to east, but also occupied the whole breadth of the continental shelf off southern Nova Scotia (Fig. 99), just as is the case in midsummer (p. 322). In September (Fig. 100) the entire Gulf, except for small regions of mixed plankton off the coast of Maine and off Massachusetts Bay, was occupied by Ceratium.

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[1] Thalassiosira was taken at Stations 10275, 10276, 10277, 10278, 10281, 10284, 10285, 10287, 10302, 10303, 10317.

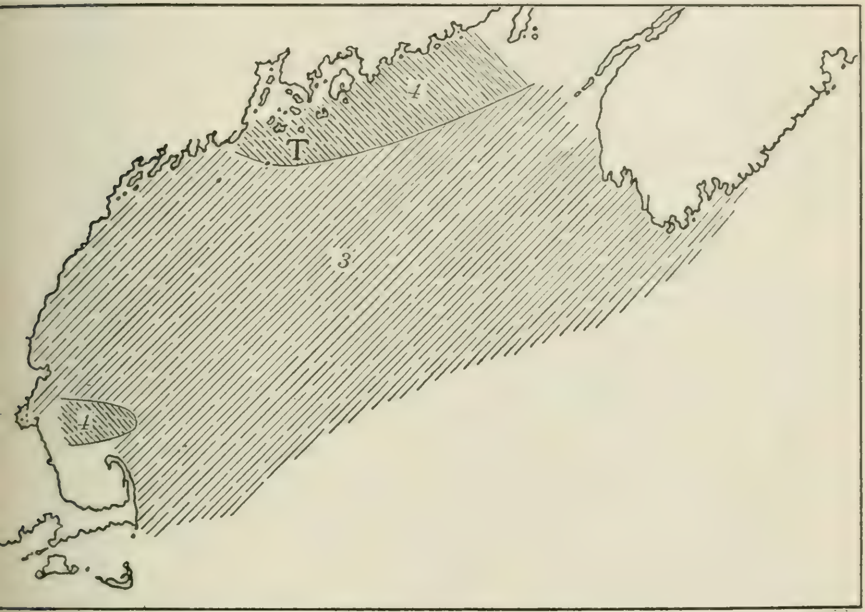

Fig. 100.—Microplankton types, August–September 1915.
3, Ceratium
4, Mixed diatom and Ceratium
T, Occurrence of Thalassiosira

The several species of Ceratium, like the prominence of the genus as a whole, undergo a definite seasonal fluctuation in the Gulf. In May, the predominant Ceratium at all the stations (except Stations

10267, 10268, 10275, and 10277, where none were detected) was one or other variety of *C. longipes* (Paulsen, 1908); *C. tripos* occurring at three stations only, as illustrated by the following table: —

Station	C. longipes	C. arctica	C. tripos	C. fusus
10266	39	8	1	4
10269	30	5	0	1
10270	20	1	0	1
10271	100+	100+	0	0
10272	18	6	1	0
10273	11	3	0	0
10276	100+	0	0	0
10278	12	1	0	0
10279	100+	0	3	1

Ceratium longipes was still the prevalent species in June, *C. tripos* being no more abundant than the month before. But by September *C. tripos* was as abundant as *C. longipes*, or outnumbered it, everywhere, except locally near the coast of Maine, (Stations 10317, 10318); and it greatly predominated over *C. longipes* off Cape Cod and in Massachusetts Bay in October (Stations 10330, 10336, 10337, 10338).

Ceratium arctica, like other typical northern species, was far more numerous in the Gulf in May than we have ever found it there in summer. But though it was most common where Cabot Current water was most in evidence (Station 10271), it occurred in small numbers at most of our other stations as well.

In June *Ceratium arctica* was limited to the extreme northeast corner of the Gulf (Stations 10283, 11284, 10286, Petit Passage), and to the waters off Shelburne. In September and October it was not detected at all.

According to Jørgensen (1911) the presence of *C. arctica* is a sure index of polar water. But while this is true for European waters, off our coast an almost equally cold habitat exists in the Gulf of St. Lawrence; and though Herdman, Thompson, and Scott (1898) did not detect *C. arctica* there, its presence in the Cabot Current off southern Nova Scotia suggests that it reaches the Gulf of Maine by that route, not from the Banks of Newfoundland, as Jørgensen supposes.

The genus Peridinium almost always occurs in the Ceratium plankton of the Gulf of Maine. In summer it usually plays a very subordinate rôle, except locally (*e. g.*, Stations 10215, 10216); but in May it not only occurred at every station where Ceratium was present, but even rivalled the latter in numbers in the eastern part of the Gulf (Stations 10270, 10272, 10273); and in September it was about as numerous as Ceratium off Swan's Island, (Station 10317) and near Matinicus Island (Station 10329).

Among the other organisms which appear in the catches, Halosphaera deserves special notice, because now recorded for the first time from the Gulf of Maine. This pelagic alga was widely distributed over the Eastern Basin of the Gulf in May (Stations 10269, 10270, 10271, 10272, 10273) though nowhere abundant; and it occurred locally off Mt. Desert in June (Stations 10284, 10286); at one Station (10310) in August. It was likewise found across the whole breadth of the continental shelf, south of Nova Scotia, in June (Stations 10291, 10293, 10294, 10296) and off Shelburne in September (Station 10313).

Halosphaera being widely distributed over the North Atlantic, (Ostenfeld, 1910), and common at Canso, Nova Scotia, in summer (Wright, 1907), was to be expected in the Gulf waters; it may have been overlooked in the hauls of earlier years. So far as our few records go they suggest that it is at its maximum in our Gulf in May, practically disappearing during the summer, which parallels its seasonal occurrence in the North Sea (Ostenfeld, 1910).[1]

Tintinnids (Cyttarocylis) are apparently never an important constituent of the plankton of the Gulf; though the records for 1914 and 1915 (so far detected at Stations 10271, 10272, 10276, 10298, 10304, 10310, 10317, 10318, 10319 in 1915) show that they may be expected anywhere there. But they sometimes appear in large numbers in the cold water along the south coast of Nova Scotia (Stations 10233, 10234, 10236, 10237, 10242; Wright, 1907). The northern distribution of this genus, and the fact that some forms are characteristically neritic, others oceanic, (Brandt, 1910), lends interest to them. But so numerous and so closely allied are the races, or species (Jørgensen, 1899) that they must be left to the specialist.

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[1] For an account of the biology of Halosphaera in the Norwegian Sea see Gran, 1902, p. 12.

TABLE OF STATIONS.

Abbreviations for nets.

A. = 4 ft. “stramin.”
B. = Meter “stramin.”
C. = Meter silk, “Sars.”
D. = 30 cm. stramin and #5 silk.
E. = 24 cm.; #5 silk.
F. = 24 cm., No. 20 silk.
G. = 24 cm. “stramin.”
H. = Helgoland.
Q. = Hensen quantitative net.
V. = $\frac{1}{2}$ meter vertical quantitative net.
$\frac{1}{2}$M. = $\frac{1}{2}$ meter horizontal net.

Cruise of 1914.

Station	Lat.	Long.	Date	Depth meters	Nets	Depth of hauls, meters
10213	42°11′	69°59′	July 19	128	F.E.B.H.Q.	0, 0, 40–0, 90–0, 110–0
214	41°49′	69°21′	“ 19	201	F.E.D.H.B.Q.	0, 0, 40–0, 125–0, 125–0, 175–0
215	41°19′	68°42′	“ 20	80	F.E.C.H.Q.	0, 0, 40–0, 60–0, 70–0
216	40°38′	68°20′	“ 20	78	F.E.B.H.Q.	0, 35–0, 40–0, 60–0, 70–0
217	40°20′	68°13′	“ 21	150		
218	40°6′	68°6′	“ 21	550+	F.C.H.B.Q.	0, 70–0, 400–0, 300–0, 500–0
219	40°39′	67°28′	“ 21	98	F.B.H.Q.	0, 40–0, 60–0, 90–0
10220	40°54′	66°13′	“ 22	700+	F.C.B.H.	0, 80–0, 300–0, 400–0
221	41°07′	66°20′	“ 22	183		
222	41°20′	66°19′	“ 22	93		
223	41°35′	66°37′	“ 23	82	F.H.Q.	0, 50–0, 75–0
224	42°03′	66°57′	“ 23	64	F.H.Q.	0, 40–0, 55–0
225	42°22′	67°11′	“ 23	274	F.C.H.Q.	0, 60–0, 240–0, 260–0
226	42°08′	66°14′	“ 24	91	F.H.Q.	0, 60–0, 85–0
227	42°19′	66°02′	“ 24	220	F.H.Q.	0, 180–0, 220–0
228	42°34′	65°51′	“ 24	95	F.H.A.	0, 60–0, 0
229	42°55′	65°41′	“ 25	113	F.A.C.	0, 0, 100–0
10230	43°19′	65°23′	“ 25	54	F.C.Q.	0, 30–0, 50–0
231	43°37′	64°57′	“ 27	58	F.B.Q.	0, 0, 50–0
232	43°12′	64°27′	“ 28	146	F.C.H.Q.	0, 50–0, 100–0, 140–0
233	42°41′	63°58′	“ 28	450+	F.B.C.H.	0, 0, 100–0, 300–0
234	43°08′	63°57′	“ 29	100	F.H.Q.	0, 75–0, 95–0
235	43°43′	63°54′	“ 29	219	F.C.	0, 80–0
236	44°17′	63°52′	Aug. 2	100	F.H.Q.	0, 50–0, 70–0
237	44°25′	63°19′	“ 6	84	F.E.H.Q.	0, 0, 60–0, 75–0

Cruise of 1914 (continued).

Station	Lat.	Long.	Date	Depth meters	Nets	Depth of hauls, meters
238	44°11′	63°07′	Aug. 6	173		
239	43°54′	62°53′	“ 7	256		
10240	43°19′	62°43′	“ 7	91		
241	43°22′	63°02′	“ 7	102		
242	43°22′	63°28′	“ 7	146	F.D.	0, 0
243	43°18′	65°27′	“ 11	64	F.E.Q.H.	0, 0, 55–0, 40–0
244	43°22′	66°26′	“ 12	56	F.E.H.Q.	0, 0, 40–0, 50–0
245	43°49′	66°51′	“ 12	126	F.E.H.Q.	0, 0, 100–0, 110–0
246	44°15′	67°23′	“ 12	201	F.E.C.H.Q.	0, 0, 50–0, 160–0, 190–0
247	44°21′	67°28′	“ 12	67	F.E.Q.	0, 0, 30–0
248	43°46′	67°58′	“ 13	201	F.E.C.H.Q.	0, 0, 50–0, 150–0, 190–0
249	43°17′	67°40′	“ 13	228	F.E.C.H.Q.	0, 0, 50–0, 175–0, 220–0
10250	43°39′	68°49′	“ 14	155	F.E.H.Q.	0, 0, 120–0, 145–0
251	43°27′	69°39′	“ 14	155	F.E.H.	0, 0, 100–0
252	42°57′	70°18′	“ 15	140		
253	42°29′	70°18′	“ 22	157	F.E.H.Q.	0, 0, 80–0, 140–0
254	42°37′	69°38′	“ 22	268	F.E.C.H.Q.	0, 0, 75–0, 225–0, 260–0
255	42°27′	68°30′	“ 23	182	F.E.H.Q.	0, 0, 150–0, 175–0
256	41°55′	69°25′	“ 23	192	F.E.H.	0, 0, 130–0
257	41°39′	69°49′	“ 24	27		
258	41°03′	70°51′	“ 25	34	F.E.H.	0, 0, 25–0
259	40°34′	70°46′	“ 25	62	F.E.H.	0, 0, 50–0
10260	40°03′	70°41′	“ 26	148	F.E.C.H.	0, 0, 60–0, 120–0
261	39°54′	70°43′	“ 26	450+	F.E.C.H.	0, 0, 400–0, 400–0
262	40°02′	70°26′	“ 26	192		
263	41°12′	70°57′	“ 27	32		
10264	42°09′	70°	“ 28	128	F.E.	0, 0

Cruise of 1915.

10266	42°30′	70°20′	May 4	137	F.E.H.V.	0, 0, 50–0, 125–0
10267	42°38′	69°36′	“ 5	273	F.E.H.V.	0, 0, 85–0, 260–0
10268	42°51′	68°43′	“ 5	196	F.E.	0, 0
10269	43°04′	67°56′	“ 6	191	F.E.H.V.	0, 0, 85–0, 175–0
10270	43°14′	67°07′	“ 6	201	F.E.C.H.V.	0, 0, 50–0, 150–0, 175–0
10271	43°26′	66°28′	“ 7	73	F.E.H.V.	0, 0, 60–0, 70–0

Cruise of 1915 (continued).

Station	Lat.	Long.	Date	Depth meters	Nets	Depth of hauls, meters
10272	43°52′	66°41′	May 10	94	F.E.H.V.	0, 0, 60–0, 80–0
10273	44°05′	67°32′	" 10	232	F.E.H.	0, 0, 125–0
10274	44°13′	67°51′	" 10	87		
10275	44°09′	68°09′	" 11	54	F. 9 ft.C.V.	0, 0, 30–0, 50–0
10276	43°44′	68°50′	" 12	84	F.E.H.V.	0, 0, 60–0, 75–0
10277	43°32′	69°46′	" 13	101	F.H.V.	0, 60–0, 75–0
10278	43°	70°12′	" 14	182	F.E. 9 ft. V.	0, 0, 60–0, 150–0
10279	42°17′	70°07′	" 26	75	F.E.H.V.	0, 0, 60–0, 65–0
10280	43°45′	69°32′	" 31	28	F.E.C.	0, 0, 15–0
10281	44°48′	66°55′	June 4	87	F.E.C.V.	0, 0, 50–0, 80–0
10282	44°25′	66°32′	" 10	194	F.E.C.H.V.	0, 0, 75–0, 175–0, 180–0
10283	44°15′	67°23′	" 10	209	F.E.H.V.	0, 0, 100–0, 180–0
10284	44°09′	67°54′	" 11	91	F.E.C.V.	0, 0, 70–0, 80–0
10285	44°09′	68°09′	" 14	54	F.½M.	0, 5–0
10286	43°59′	68°15′	" 14	95	F.½M.C.V.	0, 3–0, 70–0, 80–0
10287	43°44′	68°50′	" 14	78	F.½M.C.V.	0, 3–0, 50–0, 70–0
10288	43°28′	67°30′	" 19	227	F.½M.C.H.V.	0, 0, 85–0, 200–0, 200–0
10289	43°27′	66°51′	" 19	153		
10290	43°24′	66°22′	" 19	64	F.½M.C.V.	0, 0, 40–0, 60–0
10291	43°29′	65°08′	" 23	78	F.½M.C.V.	0, 0, 60–0, 70–0
10292	43°19′	64°59′	" 23	157		
10293	42°59′	64°43′	" 23	87	F.½M.C.V.	0, 0, 60–0, 75–0
10294	42°36′	64°27′	" 23	176	F.½M.C.V.	0, 0, 100–0, 170–0
10295	42°22′	64°16′	" 24	500+	F.½M.C.	0, 0, 500–0
10296	42°28′	65°37′	" 24	89	F.C.	0, 50–0
10297	42°17′	66°03′	" 25	236	F.	
10298	42°26′	67°45′	" 25	245	F.V.	0, 200–0
10299	42°32′	69°14′	" 26	219	F.C.V.	0, 200–0, 200–0
10300	Off Race Point, Cape Cod		July 7	59	F.C.	0, 59–0
10301	44°31′	67°24′	" 15	73	F.½M.C.	0, 0, 50–0
10302	44°08′	68°15′	" 19	53	F.½M.C.	0, 0, 40–0
10303	43°46′	69°23′	Aug. 4	80	F.½M.C.V.	0, 0, 60–0, 70–0
10304	43°32′	67°35′	" 6–7	219	F.E.C.V.	0, 0, 150–0, 200–0
10305	44°08′	68°15′	" 18	63	F.E.C.	0, 0, 40–0
10306	42°31′	70°19′	" 31	147	F.½M.C.H.V.	0, 0, 40–0, 110–0, 140–0
10307	42°40′	69°34′	" 31	245	F.½M.C.H.V.	0, 0, 220–0, 220–0,235–0
10308	42°52′	68°40′	Sept. 1	185	F.½M.H.	0, 0, 50–0

Cruise of 1915 (continued).

Station	Lat.	Long.	Date	Depth meters	Nets	Depth of hauls, meters
10309	43°08′	67°52′	Sept. 1	221	F.½M.C.V.	0, 0, 130–0, 200–0
10310	43°15′	67°03′	“ 2	201	F.½M.C.V.	0, 0, 175–0, 190–0
10311	43°22′	66°17′	“ 2	73	F.½M.C.V.	0, 0, 50–0, 60–0
10312	43°14′	65°37′	“ 2	58		
10313	43°28′	65°06′	“ 6	78	F.½M.C.V.	0, 0, 50–0, 70–0
10314	43°20′	64°59′	“ 6	164		
10315	43°49′	66°44′	“ 7	97	V.	80–0
10316	44°32′	67°22′	“ 11	64	F.½M.C.V.	0, 0, 30–0, 60–0
10317	44°05′	68°26′	“ 15	31	F.½M.C.V.	0, 0, 20–0, 28–0
10318	43°43′	69°17′	“ 16	78	F.½M.C.V.	0, 0, 50–0, 70–0
10319	43°28′	70°16′	“ 20	54	F.½M.C.V.	0, 0, 25–0, 35–0
10320	42°25′	70°33′	“ 29	82	F.½M.C.V.	0, 0, 50–0, 70–0
10321	42°10′	70°22′	“ 29	48	F.½M.S.C.V.	0, 0, 48–0, 25–0, 40–0
10322	42°04′	70°16′	Oct. 1	27	F.½M.C.	0, 0, 15–0
10323	42°17′	70°07′	“ 1	87	F.½M.C.V.	0, 0, 70–0, 80–0
10324	42°31′	70°19′	“ 1	158	V.	150–0
10325	43°	70°12′	“ 4	183	V.	175–0
10326	43°24′	69°53′	“ 4	155	V.	145–0
10327	44°32′	67°20′	“ 9	62	F.E.C.V.	0, 0, 40–0, 60–0
10328	44°06′	68°14′	“ 9	66	F.½M.C.V.	0, 0, 40–0, 60–0
10329	43°44′	68°51′	“ 9	69	F.½M.C.V.	0, 0, 40–0, 60–0
10330	42°34′	70°37′	“ 18	47	F.½M.C.	0, 0, 25–0
10331	41°19′	70°55′	“ 22	34	F.½M.C.V.	0, 0, 25–0, 30–0
10332	40°51′	70°55′	“ 22	53	F.½M.C.V.	0, 0, 45–0, 50–0
10333	40°26′	70°56′	“ 22	82	F.½M.C.V.	0, 0, 65–0, 75–0
10334	40°09′	71°	“ 22	165		
10335	41°26′	70°17′	“ 25		F.½M.C.	0, 0, 8–0
10336	41°42′	69°53′	“ 26	51	F.½M.C.V.	0, 0, 40–0, 50–0
10337	42°05′	70°18′	“ 26	62	F.½M.C.V.	0, 0, 40–0, 60–0
10338	42°19′	70°30′	“ 27	82	F.½M.C.V.	0, 0, 60–0, 80–0
10339	42°31′	70°36′	“ 27	75	V.	75–0

TABLE OF TEMPERATURES, SALINITIES AND DENSITIES.

Density is at the temperature *in situ*, and = specific gravity at T°, compared to distilled water at 4° C, × 1000. The density readings are connected for pressure by Ekman (1910) Table IV alone, this being sufficiently accurate for the small depths involved. They are given only for selected stations (p. 200).

1914.

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10213	0	16.83°	31.17	24.35
	20	9.06°		
	40	5.38°	32.34	25.67
	100	3.97°	32.74	26.49
	120		32.95	
	130	4.41°		
10214	0	17.5 °	31.80	23.12
	20	15.75°		
	40	7.25°	32.25	25.48
	100	4.22°	32.92	26.64
	150	5.12°	33.28	
	190	5.53°	33.49	27.4
10215	0	16.68°	32.09	23.53
	20	12.24°		
	40	10.43°	32.81	25.47
	70	9.62°	32.88	25.67
10216	0	18.6 °	33.10	23.87
	20	13.9 °		
	40	13.04°	33.58	25.52
	70	10.64°	34.88	27.21
10217	0	17.3 °	32.74	23.82
	20	10.64°		
	40	9.15°	33.60	26.24
	100	11.80°		
	150	10.63°	35.23	27.87
10218	0	20.48°	34.42	24.37
	40	17.7 °	36.04	26.52
	100	14.87°	35.82	26.59
	200	10.85°	35.32	28.18
	300	9.46°	35.14	28.63
	400		34.96	
	500	5.25°	34.90	29.95

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10219	0	18.9 °	33.55	23.68
	20	17.33°		
	40	16. °		
	90	10.28°	34.65	
10220	0	19.98°	33.82	23.9
	40	15.35°	34.97	26.17
	100	11.2 °	35.23	27.46
	200	8.18°	35.01	28.27
	300	6.9 °	34.94	28.78
	400	5.55°	34.87	
	500	5.02°	34.87	30.12
10221	0	16.5 °	32.74	24.05
	40	16.18°	34.78	25.79
	100	12. °	35.16	27.18
	160	10.78°	35.25	27.93
10222	0	14.67°	32.48	24.28
	90	8.98°	34.18	26.95
10223	0	13.33°	32.59	24.57
	20	10.86°	32.63	
	40	8.90°	32.78	25.61
	75	7.92°	33.03	26.1
10224	0	11.11°	32.47	24.84
	30	10.76°	32.54	25.03
	55	10.78°	32.61	25.18
10225	0	15.28°	32.16	23.81
	40	10. °	33.17	25.76
	100	9.53°	34.69	27.36
	150	9.33°	35.05	27.89
	200	8.4 °	35.08	28.32
	250	7.93°	35.08	28.51
10226	0	15.28°	32.25	23.88
	40	12.6 °	32.34	25.51
	85	6.6 °	33.03	26.42
10227	0	15.11°	32.47	24.06
	40	9.3 °	33.04	25.82

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10227	80	8.91°	34.18	26.9
	130	8.8 °	34.78	27.59
	170	7.15°	34.99	
	220	6.95°	35.03	28.49
10228	0	14.72°	32.20	23.84
	40	8.35°	33.40	26.33
	85	8.5 °	34.25	27.10
10229	0	11.44°	32.01	
	40	6.17°	32.38	25.7
	100	5.96°	32.92	26.4
10230	0	10.28°	31.47	24.24
	30	3.03°	32.07	25.78
	50	3.14°	32.34	25.98
10231	0	6.62°	31.62	24.85
	30	1.81°	31.98	25.77
	50	1.91° 1.97°	32.20	25.95
10232	0	15. °	31.26	23.12
	40	4.38°	31.74	25.42
	100	2.88° and 3.45°	32.88	26.68
	140	5.55° and 5.76°	33.64	
10233	0	16.95°	31.22	22.85
	40	7.34°	32.90	25.99
	100	7.59°	34.16	27.26
	200	7.74°		
	300	7.62°	34.96	28.72
	400	5.3 °	34.92	
	500	4.98°	34.83	29.89
10234	0	14.72°	31.29	23.15
	40	3.13°	31.80	25.56
	95	2.8 °	32.88	26.66
10235	0	14.17°	30.95	23.09
	40	5.52°	31.91	25.44
	100	5.26°	33.60	27.10
	220	8.26°	34.56	28.00

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10236	0	12.78°	30.90	23.24
	40	3.38°	31.71	25.47
	85	0.76°	32.09	26.11
10237	0	14.44°	30.86	22.91
	30	3.5 °	31.35	
	50	2.15°	31.80	
	75	1.10°	32.34	
10238	0	15.56°	31.53	23.23
	40	6.92°	32.01	25.34
	80	3.35°	32.97	26.68
	120	6.7 °	33.93	27.25
	165	8.87°	34.81	27.76
10239	0	15. °	31.22	23.09
	40	5.55°	32.10	24.81
	100	5.89°	33.82	27.13
	150	8.82°	34.78	
	200	8.84°	34.92	28.03
	250	8.35°	34.92	
10240	0	15. °	31.98	23.70
	20	11.9 °	32.21	
	40	5.55°	33.28	26.54
	60	5.72°	33.69	
	80	5.8 °	33.78	
10241	0	16.67°	31.18	22.74
	40	5.19°	32.34	25.78
	90	8.77°	34.45	27.63
10242	0	15.83°	31.29	23.15
	40	4.4 °	32.07	25.69
	100	6.15°	33.75	27.07
	140	7.92°	34.45	
10243	0	13.61°	31.67	23.77
	30	7.47°	31.67	
	55	3.51°	31.98	
10244	0	10. °	32.84	25.31
	30	9.64°	32.86	25.5
	55	9.60°	32.90	25.71

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10245	0	14.44°	32.52	24.21
	40	9.44°	33.42	26.10
	80	8.75°	33.87	26.65
	120	8.54°	34.11	27.11
10246	0	14.44°	33.06	24.64
	40	8.35°	33.35	26.19
	100	6.28°	33.57	26.91
	150	7.58°	34.05	
	190	8.17°	34.47	27.8
10247	0	10.44°	32.52	24.97
	30	8.97°		
	60	8.88°	32.84	
10248	0	13.33°	32.65	24.51
	40	8.45°	32.97	25.91
	100	7.18°	33.51	26.74
	150	6.04°	33.64	
	190	8.34°	34.49	27.82
10249	0	17.5 °	31.91	23.04
	40	6.38°	32.74	25.97
	100	5.31°	33.06	26.64
	150	6.04°	33.55	27.15
	220	5.83°	33.48	27.2
10250	0	13.05°	32.52	24.5
	40	8.59°	32.92	25.87
	100	7.04°	33.24	26.55
	145	6.26°	33.39	
10251	0	16.56°	31.92	23.34
	40	5.65°	32.38	25.81
	100	4.41°	32.70	26.41
	145	4.93°	33.24	
10252	0	16.22°	31.64	23.2
	40	7.8 °	32.39	25.45
	90	4.64°	32.56	26.29
	130	3.66°	32.79	26.74
10253	0	18.89°	31.29	22.23
	40	6.47°	32.29	25.63
	100	4.64°	32.43	26.23
	140	4.49°	32.50	

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10254	0	20. °	31.55	22.17
	40	5.75°	32.43	25.75
	100	4.36°		
	150	5.51°	33.42	27.11
	200	6.8°	34.11	27.7
	260	7.09°	34.23	28.09
10255	0	19.17°	31.89	22.71
	40	7.81°	32.52	25.55
	100	3.95°	32.81	26.53
	150	5.13°	33.33	
	175	6.24°	33.87	
10256	0	19.56°	31.80	22.55
	40	6.57°	32.38	25.74
	100	4.24°	32.88	26.61
	150	5.38°	33.51	
	180	5.68°	33.64	
10257	0	20. °	32.05	
	25	6.8 °	32.09	
10258	0	19.72°	32.16	
	15	14.29°	32.43	
	30	12.09°	32.52	
10259	0	21.95°	33.69	
	25	14.83°	33.53	
	55	9.67°	33.60	
10260	0	22.89°	33.78	
	40	13.67°	34.09	
	100	11.63°	35.23	
	140	11.45°	35.41	
10261	0	23.5 °	34.11	
	100	13.06°	35.46	
	200	11.99°		
	300	9.91°	35.16	
	450	7.26°	35.16	
10262	0	21.89°	33.64	
	40	13.07°	33.89	
	100	11.34°	35.14	
	180	10.35°	35.26	

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10263	0	17.89°	32.12	
	17	13.30°	32.45	
10264	0	16.67°		
	30	7.34°	32.05	
	80	5.65°	32.48	

1915.

10266	0	6.11°	32.32	25.51
	50	3.55°	32.68	26.22
	130	3.55°	32.81	26.84
10267	0	6.1 °	33.03	26.04
	50	5. °	33.15	26.48
	130	4.69°	33.17	26.94
	260	6.59°	34.02	27.99
10268	0	6.1°	32.79	25.85
	50	4.78°	32.81	26.2
	100	4.47°	33.04	26.69
	190	5.6 °	33.53	27.10
10269	0	4.4 °	32.50	25.83
	50	4.28°	32.68	26.21
	100	4.44°	32.95	26.67
	185	5.82°	33.22	27.04
10270	0	3.6 °	31.78	25.3
	50	3.04°	32.03	25.78
	100	3.9 °	32.86	26.59
	190	5.95°	33.58	27.37
10271	0	3. °	31.89	25.43
	35	3.24°	31.94	25.61
	70	3.27°	31.94	25.8
10272	0	3.9 °	32.05	
	50	3.42°	32.09	
	90	3.6 °	32.30	
10273	0	4.7 °	32.23	
	50	4.81°	32.57	

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10373	100	5.1°	33.03	
	150	4.98°	33.28	
	225	6.28°	33.66	
10274	0	4.2°		
	40		32.20	
	80	3.97°	32.23	
10275	0	4.4°	31.51	
10276	0	5.°	31.8	
	40	4.22°	32.34	
	80	4.22°	32.43	
10277	0	7.8°	29.58	
	50	4.18°	32.38	
	95	4.15°	32.45	
10278	0	7.8°	32.03	
	50	4.04°	32.63	
	100	3.45°	32.7	
	175	3.7°	32.94	
10279	0	10.°	31.89	
	40	5.2°	32.68	
	70	3.82°	32.68	
10280	0	6.9°	31.56	
	25	5.56°	31.83	
10281	0	4.4°	31.82	
	40	4.63°	31.82	
	80	4.58°	31.83	
10282	0	6.4°	31.89	
	50	5.71°	32.41	
	100	5.2°	32.83	
	180	5.25°	33.06	
10283	0	5.4°	31.98	
	50	5.27°		
	100	5.°	32.70	
	180	3.54°	33.66	

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10284	0	5.4°	32.07	
	40	5.11°	32.21	
	80	5.14°	32.45	
10285	0	8.°	31.76	
10286	0	7.5°	32.16	
	40	5.44°	32.30	
	80	5.18°	32.41	
10287	0	7.8°	31.94	
	35	5.83°	32.16	
	70	4.66°	32.36	
10288	0	9.7°	32.41	
	50	5.6°	32.50	
	100	4.86°	33.06	
	150	5.6°	33.46	27.21
	220	6.21°	33.95	27.81
10289	0	7.8°	32.25	
	50	5.9°	32.66	
	100	5.7°	33.24	
	150	5.87°	33.48	
10290	0	6.1°	32.07	
	25	5.9°	32.09	
	60	5.85°	32.12	
10291	0	8.9°	30.93	23.93
	30	3.47°	31.36	25.16
	75	.96°	31.92	25.94
10292	0	8.6°	31.33	24.35
	50	.7°	31.83	25.77
	75	.7°	32.12	
	100	2.02°	32.68	26.62
	150	4.32°		
10293	0	10.°	31.36	24.15
	40	1.54°	31.91	25.75
	85	1.6°	32.50	26.41

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10294	0	9.7°	31.06	23.98
	40	2.85°	31.83	25.59
	80	2.12°	32.79	26.62
	120	7.5°	34.34	27.42
	170	8.28°	34.67	27.85
10295	0	11.1°	32.39	24.78
	80	3.63°	34.27	27.67
	200	8.15°	34.97	28.24
	300	7.3°	34.94	28.73
	500	4.91°	34.94	29.98
10290	0	10.°	31.44	
	40	2.8°	32.29	
	80	7.36°	33.49	
10297	0	10.°	32.56	25.08
	40	8.2°	33.31	26.19
	100	8.14°	34.18	27.14
	150	7.72°	34.67	27.89
	225	7.2°	34.92	28.43
10298	0	12.5°	32.56	24.66
	50	5.18°	32.59	26.05
	100	5.02°	33.04	26.63
	150	5.68°	33.48	27.15
	225	6.91°	34.60	28.17
10299	0	13.6°	32.50	24.41
	50	6.22°	33.04	26.28
	100	4.6°	33.08	26.70
	210	5.67°	33.82	27.56
10300	0	16.6°	31.4	
	50	6.7°	32.2	
10301	0	8.9°	31.58	
	60	7.16°	32.03	
10302	0	11.6°	31.83	
	20	7.97°	31.98	
	45	7.24°	32.16	

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10303	0	11.6°	31.87	
	35	8.01°	32.14	
	75	5.96°	32.41	
10304	0	11.4°	32.63	
	50	8.26°	32.67	
	100	6.22°	33.12	
	150	4.78°	33.73	
	200	6.89°	34.16	
10305	0	10.8°	31.94	
	25	9.37°	32.05	
	50	8.79°	32.34	
10306	0	16.1°	31.24	22.89
	50	7.24°	32.39	25.63
	100	5.97°	32.50	26.08
	140	5.78°	32.57	26.33
10307	0	17.6°	32.47	23.39
	50	7.77°	32.81	25.91
	100	5.01°	33.12	26.7
	150	5.1°	33.28	27.06
	200	5.7°	33.75	27.37
	235	6.36°	34.23	28.08
10308	0	15.8°	32.52	23.88
	40	9.02°	32.59	25.46
	90	6.36°	33.03	26.47
	165	5.63°	33.69	27.37
10309	0	15.5°	32.47	23.99
	50	9.44°	32.66	25.4
	100	5.72°	33.1	26.62
	150	5.77°	33.60	27.25
	210	5.98°	33.60	27.44
10310	0	13.3°	32.41	24.42
	50	7.05°	32.88	26.02
	100	5.56°	33.26	26.74
	190	7.1°	34.33	27.82
10311	0	9.4°	32.23	24.9
	30	10.28°	32.47	25.1
	65	10.1°	32.56	25.36

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10312	0	13.3 °	31.49	
	25	9.4 °	31.73	
	50	7.38°	32.	
10313	0	15. °	30.7	
	20	3.38°	30.73	
	50	3.33°	32.16	
	70	2.22°	32.43	
10314	0	15. °	31.22	
	25	7.89°	31.82	
	50	3.3 °	32.34	
	75	4.95°	33.01	
	100	5. °	33.12	
	150	5.05°	33.40	
10315	0	12.2 °	32.88	
	50	11.2 °	33.19	
	90	10. °	33.42	
10316	0	10.28°	32.3	
	60	9.95°	32.43	
10317	0	11.6 °	32.5	
	28	10.95°	32.52	
10318	0	13.6 °	32.30	
	35	10.1 °*	32.27	
	70	8.61°	32.56	
10319	0	15.5 °		
	25	10.5 °	31.83	
	50	8.5 °	32.12	
10320	0	10.5 °	31.91	
	35	10.7 °*	31.98	
	70	7. °	32.30	
10321	0	11.4 °	31.73	
	20		31.83	
	40	11.22°		

*Approximate only.

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10322	0	13.4°	31.38	
	25	12.95°	31.60	
10323	0	11.4°	32.07	
	40	11.°*	32.25	
	80	6.°	33.06	
10324	0	10.3°	32.21	
	40		32.25	
	80	7.11°	32.5	
	120	7.2°*	32.57	
	150	6.78°	32.66	
10325	0	11.6°	32.21	
	50	7.33°	32.39	
	100	6.4°	32.81	
	175	5.28°	33.22	
10326	0	11.9°	32.41	
	50	7.61°	32.9	
	100		32.9	
	145	5.39°	33.48	
10327	0	9.4°	32.75	
	30		32.74	
	60	9.83°	32.77	
10328	0	9.4°	32.66	
	30		32.70	
	60	10.1°	32.79	
10329	0	10.°	32.47	
	30	10.3°	32.56	
	60	8.95°	32.84	
10330	0	11.4°	31.8	
10331	0	14.4°*	32.1	
	30	14.5°	32.14	
10332	0	13.9°	32.32	
	25		32.45	
	50	13.1°	32.92	

*Approximate only.

Station	Depth meters	Temp. Cent.	Salinity ‰	Density
10233	0	13.3°	32.65	
	25	13.2°	32.74	
	50		32.97	
	80	11.89°	33.68	
10334	0	15.5°	33.86	
10335	0	13.°	32.09	
10336	0	10.5°	32.	
	25		32.03	
	50	9.39°	32.41	
10337	0	11.1°	31.89	
	30		31.94	
	60	10.39°	32.14	
10338	0	11.°	31.82	
	40	9.4°*	32.2	
10339	0	10.8°	31.91	
	35		32.2	
	70	7.28°	32.43	

TABLE OF TEMPERATURES AND SALINITIES AT CORRESPONDING LOCALITIES, 1912–1915.

In part these are taken directly from the tables of temperature and salinity (p. 333: 1914a, 1915), in part reconstructed from the temperature and salinity sections.

Sink off Cape Ann.

	Temperatures				Salinities			
Depth meters	1912 10002 July 10	1913 10087 Aug. 9	1914 10253 Aug. 22	1915 10306 Aug. 31	1912 10002 July 10	1913 10087 Aug. 9	1914 10253 Aug. 22	1915 10306 Aug. 31
0	18.33°	16.67°	18.89°	16.11°	31.74	32.09	31.29	31.24
20	9.44°	10.56°	11.2°	10.5°	32.05	32.48	31.93	31.95
40	6.56°	6.67°	6.47°	8.°	32.36	32.69	32.29	32.3
60	5.°	5.44°	5.4°	6.7°	32.61	32.74	32.36	32.42
80	4.61°	5.28°	4.8°	6.3°	32.82	32.76	32.4	32.44
100	4.61°	5.17°	4.64°	6.15°	32.9	32.77	32.43	32.5
120		5.17°	4.5°	6.°	32.92	32.76	32.47	32.52
140			4.49°	5.9°			32.5	32.57

*Approximate only.

Western Basin.

	Temperatures				Salinities			
Depth meters	1912 10007 July 15	1913 10088 Aug. 9	1914 10259 Aug. 22	1915 10307 Aug. 31	1912 10007 July 15	1913 10088 Aug. 9	1914 10254 Aug. 22	1915 10307 Aug. 31
0	17.78°	19.17°	20. °	17.22°	31.62	32.21	31.55	32.47
20	11.72°	12.56°	11.5 °	12.5 °	31.95	32.5	32.04	32.6
40	8. °	8.72°	5.75°	9. °	32.3	32.72	32.43	32.74
60	6. °	6.39°	4.9 °	7. °	32.6	32.9	32.69	32.88
80	5. °	5.44°	4.5 °	5.7 °	32.9	33.08	32.88	33.1
100	4.67°	5.17°	4.36°	5.15°	33.14	33.24	33.05	33.12
120	4.61°	5.56°	4.7 °	5.2 °	33.33	33.39	33.2	33.2
140	4.61°	5.89°	5.3 °	5.25°	33.49	33.55	33.35	33.24
160	4.61°	6.17°	5.9 °	5.7 °	33.6	33.71	33.55	33.39
180	4.61°	6.28°	6.5 °	5.8 °	33.69	33.85	33.8	33.62
200	4.61°	6.28°	6.8 °	5.87°	33.75	33.96	34.11	33.75
220	4.61°	6.28°	7. °	6.2 °	33.78	34.05	34.19	34.
240		6.28°	7.04°	6.4 °		34.13	34.21	34.2
260		6.28°	7.09°			34.23	34.23	

Center of Gulf, near Cashe's Ledge.

	Temperatures			Salinities		
Depth meters	1913 10090 Aug. 10	1914 10255 Aug. 23	1915 10308 Sept. 1	1913 10090 Aug. 10	1914 10255 Aug. 23	1915 10308 Sept. 1
0	16.11°	19.17°	15.8°	32.56	32.89	32.52
20	11.11°	12.2 °	11.2°	32.7	32.25	32.55
40	7.22°	7.81°	9.1°	32.86	32.52	32.59
60	6.56°	5.7 °	7.7°	33.	32.68	32.75
80	6.44°	4.3 °	6.8°	33.15	32.74	32.93
100	6.39°	3.95°	6.3°	33.27	32.81	33.1
120	6.44°	4.1 °	6. °	33.4	33.	33.3
140	6.44°	4.7 °	5.8°	33.53	33.21	33.45
160	6.50°	5.5 °	5.7°	33.7	33.52	33.64
180	6.56°	6.3 °		33.83		
200	6.61°					

West side of Eastern Basin.

	Temperatures				Salinities			
Depth meters	1912 10027 Aug. 14	1913 10092 Aug. 11	1914 10249 Aug. 13	1915 10309 Sept. 1	1912 10027 Aug. 14	1913 10092 Aug. 11	1914 10249 Aug. 13	1915 10309 Sept. 1
0	15. °	16.67°	17.5 °	15.56°	32.66	32.59	31.91	32.47
20	9.22°	8.95°	9.1 °	12.5 °	32.91	32.86	32.4	32.53
40	7.78°	6.67°	6.38°	10.3 °	33.14	33.05	32.74	32.6
60	7.39°	5.76°	5.7 °	8.5 °	33.36	33.14	32.84	32.75
80	7.22°	5.56°	5.3 °	6.8 °	33.56	33.21	32.95	32.9
100	6.95°	5.89°	5.31°	5.9 °	33.69	33.33	33.06	33.1
120	6.61°	6.05°	5.5 °	5.8 °	33.76	33.46	33.29	33.3
140	6.17°	6.05°	5.9 °	5.9 °	33.81	33.62	33.49	33.5
160	6.05°	6.05°	6.1 °	5.9 °	33.86	33.77	33.55	33.64
180	6. °	6.11°	6. °	6. °	33.89	33.89	33.54	33.75
200		6.11°	5.9 °	6.1 °		33.99	33.51	33.8
220		6.05°	5.83°			34.08	33.48	
240		6.05°				34.14		

German Bank.

	Temperatures				Salinities			
Depth meters	1912 10029 Aug. 14	1913 10095 Aug. 12	1914 10244 Aug. 12	1915 10311 Sept. 2	1912 10029 Aug. 14	1913 10095 Aug. 12	1914 10244 Aug. 12	1915 10311 Sept.2
0	10.33°	8.89°	10. °	9.44°	32.7	32.79	32.84	32.23
20	9.83°	8.67°	9.85°	10. °	32.75	32.92	32.85	32.4
40	9.67°	8.61°	9.64°	10.1 °	32.8	32.93	32.88	32.5
60	9.61°	8.56°	9.65°	10.1 °	32.92	32.94	32.90	32.55

Off Lurcher Shoal.

	Temperatures				Salinities			
Depth meters	1912 10031 Aug. 15	1913 10196 Aug. 12	1914 10245 Aug. 12	1915 10315 Sept. 7	1912 10031 Aug. 15	1913 10196 Aug. 12	1914 10245 Aug. 12	1915 10315 Sept. 7
0	13.33°	12.12°	14.44°	12.22°	32.84	32.75	32.52	32.88
25	11.8 °	10.5 °	10.3 °	11.3 °	33.	32.97	32.95	32.99
50	10.7 °	9.4 °	9.2 °	10.11°	33.44	33.35	33.57	33.19
75	10.97°	8.6 °	8.8 °	9.9 °	33.64	33.4	33.84	33.36
100	8.5 °	7.4 °	8.6 °		33.76	33.41	33.97	

Northeast corner of Gulf.

	Temperatures			Salinities		
Depth meters	1912 10036	1913 10097	1914 10246	1912 10036	1913 10097	1914 10246
0	10.56°	12.78°	14.44°	32.75	32.75	33.06
20	10.17°	11.67°	10. °		32.76	33.14
40	9.33°	10.44°	8.35°		32.77	33.35
60	8.89°	9.17°	7.25°		32.8	33.34
80	8.61°	8.39°	6.57°		32.91	33.5
100	8.28°	7.72°	6.28°		33.08	33.57
120	8.00°	7.28°	6.57°		33.24	33.76
140	7.61°	6.67°	7.25°		33.45	33.95
160	7.44°	6.5 °	7.8 °		33.65	34.17
180	7.44°	6.22°	8.0 °	34.31	33.87	34.38
200		6.00°	8.17° (at 190m.)		34.09	34.47

Off the Northeast Coast of Maine.

	Temperatures			Salinities		
Depth meters	1912 10033 Aug. 16	1913 10098 Aug. 13	1914 10247 Aug. 12	1912 10033 Aug. 16	1913 10098 Aug. 13	1914 10247 Aug. 12
0	10.61°	10.28°	10.44°	32.68	32.47	32.52
20	10.11°	9.56°	10.15°	32.68	32.55	32.62
40	9.72°	9.33°	8.92°	32.68	32.62	32.73
60	9.61°	9.11°	8.88°	32.68	32.7	32.84
80						

Off Matinicus.

	Temperatures			Salinities		
Depth meters	1912 10039 Aug. 22	1913 10101 Aug. 14	1914 10250 Aug. 14	1912 10039 Aug. 22	1913 10101 Aug. 14	1914 10250 Aug. 14
0	13.33°	11.95°	13.05°	32.5	32.68	32.52
20	11.28°	10.05°	10.2 °		32.81	32.75
40	9.33°	9.44°	8.59°		32.94	32.92
60	8.89°	8.95°	7.9 °		33.06	33.04
80	8.67°	8.67°	7.4 °		33.19	33.14
100	8.33°	8.39°	7.04°		33.29	33.24
120	7.89°		6.6 °			33.3
140	7.28°		6.2 °	33.6		33.37

Off Cape Elizabeth.

	Temperatures			Salinities		
Depth meters	1912 10019 July 29	1913 10103 Aug. 14	1914 10251 Aug. 14	1912 10019 July 29	1913 10103 Aug. 14	1914 10251 Aug. 14
0	13.89°	16.11°	16.56°	31.92	31.83	31.92
20	11.05°	11.33°			32.38	
40	8.33°	8.72°	5.65°		32.64	32.38
60	6.89°	7.39°			32.74	
80	5.83°	6.95°			32.8	
100	5.67°	6.67°	4.41°	32.97	32.84	32.60
120						
140			4.9°			33.2

Trough between Jeffrey's Ledge and Coast.

	Temperatures			Salinities		
Depth meters	1912 10011 + 12b July 17–23	1913 10104 Aug. 15	1914 10252 Aug. 15	1912 10011 + 12b July 17–23	1913 10104 Aug. 15	1914 10252 Aug. 15
0	15. °	17.22°	16.22°	31.92	31.85	31.64
20	8.33°	9.61°	12. °	32.23	32.25	32.12
40	6.11°	7.78°	7.8 °	32.52	32.56	32.39
60	4.78°	6.61°	6.2 °	32.69	32.84	32.48
80	4.61°	5.83°	5. °	32.71	33.	32.54
100	4.61°	5.22°	4.3 °	32.77	33.06	32.6
120	4.61°	4.83°	3.8 °	32.85	33.08	32.72
140		4.56°	3.66°	32.95	33.1	32.79
160	4.11°	4.33°	(At 130m.)	33.01		
180				(at 150m.)		(at 130m.)

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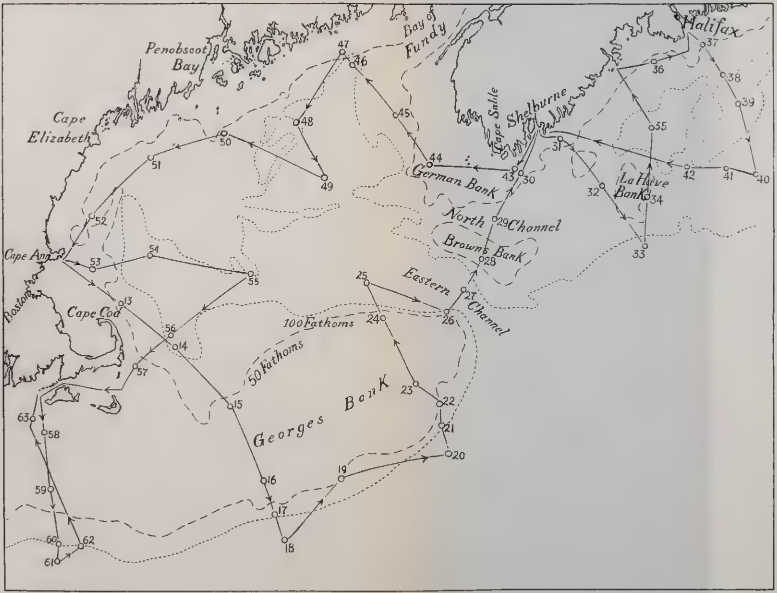
PLATE 1.

PLATE 1.

Chart of the route of the Grampus, July and August 1914, showing Stations 10213 to 10263; the 50 and 100 fathom curves, and the offshore banks.


Penobscot Bay
Bay of Fundy
Halifax
Cape Elizabeth
Cape Sable
Shelburne
German Bank
La Have Bank
North Channel
Browns Bank
Eastern Channel
Cape Ann
Boston
Cape Cod
100 Fathoms
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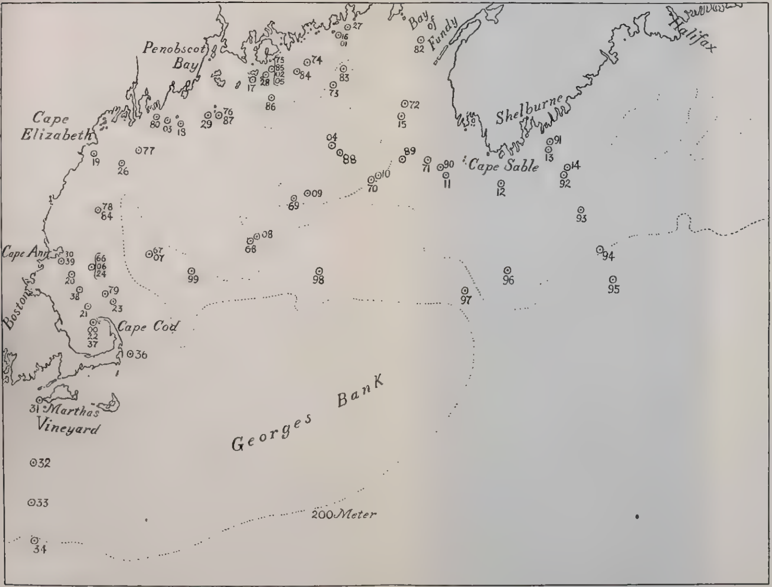
HELIOTYPE CO. BOSTON

PLATE 2.

PLATE 2.

Stations occupied by the GRAMPUS, May to October 1915 (Stations 10266 to 10339) with the 200 meter curve. For the offshore banks, see Plate 1.

1917. Stations 10
anks, see Plate 1.


Penobscot Bay
Bay of Fundy
Halifax
Cape Elizabeth
Shelburne
Cape Sable
Cape Ann
Boston
Cape Cod
Martha's Vineyard
Georges Bank
200 Meter
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HELIOTYPE CO. BOSTON

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NEW BLASTOIDS AND BRACHIOPODS FROM THE ROCKY MOUNTAINS.

By Thomas H. Clark.

With Two Plates.

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August, 1917.

No. 9.— *New Blastoids and Brachiopods from the Rocky Mountains.*

By Thomas H. Clark.

Blastoidea.

Blastoids are so rare in the Rocky Mountains that the discovery of new species of these fossils in that region is of considerable interest and importance. In 1915, while a member of the Harvard Summer School of Geology, I was fortunate enough to find several specimens belonging to Pentremites and Schizoblastus in the Carboniferous limestone of southwestern Montana. The discovery of these fossils here is important from another point of view, namely, that the Pentremites were collected from that part of the Carboniferous limestone which must be acknowledged to be of Pennsylvanian age. The specimens of Schizoblastus and one Pentremites came from Squaw Creek, off the West Gallatin River, and the other Pentremites were collected at Old Baldy, near Virginia City, Montana.

At Old Baldy, there is an exposure of Carboniferous limestone, the greater part of which contains fossils characteristic of the Madison formation (Mississippian). The limestone is capped by the Quadrant quartzite, which is recognized as Upper Carboniferous. Immediately below the quartzite there is a considerable thickness of limestone which contains Pennsylvanian fossils. Schuchert, in 1910, writing of the Old Baldy fossils stated that "in the light of the Arkansas (Morrow formation) collections, these fossils must now be referred to the Pottsvillian" (Bull. Geol. soc. Amer., **20**, p. 426–606).

Since 1873, when Meek published his lists of fossils collected from the rocks of Montana (Meek, Rept. U. S. geol. surv. Montana Idaho, Wyoming, Utah, 1873, p. 463–478), nothing has been published concerning Pentremites in the Rocky Mountains, and Meek was the first to discover this genus west of Iowa and Missouri. In the report referred to above the occurrence of the following five species is noted: — *Pentremites conoideus, Pentremites subconoideus, Pentremites symmetricus, Pentremites godoni?, Pentremites bradleyi.* These come from two localities in Montana. In 1905, Mr. Earl Douglass found a specimen at Old Baldy, which was identified by Dr. P. E. Raymond as *Pentremites conoideus*, and the description of which appears in this paper for the first time. The discovery by the writer of three new species of Pentremites adds considerably to the representation of the genus in the Rocky Mountain Region, and suggests the desirability of obtaining further information upon the occurrence of the genus in that region.

The genus Schizoblastus has had a similar history. In 1874 White described one species, *Schizoblastus lotoblastus*, from the Subcarboniferous of Arizona, and in 1879 noted the same species from the Carboniferous of the Teton range. Dr. W. P. Haynes brought back from the Carboniferous at Squaw Creek, Montana, three specimens of the genus, which, owing to their imperfect preservation, he could not distinguish from *Schizoblastus lotoblastus*. From the same locality the writer collected several silicified specimens which, etched, were plainly not conspecific with *Schizoblastus lotoblastus*.

A blastoid like *Pentremites subconoideus* has been found at Frank, Alberta, in the Carboniferous limestone, and indicates the occurrence of blastoids in that part of the Rockies.

Dr. K. F. Mather, in 1915, published The Fauna of the Morrow Formation of Arkansas (Bull. Sci. lab. Denison univ., 1915, **28**, p. 59.) in which he described two species of Pentremites from the Pennsylvanian. The possibility that the limestone at Old Baldy, or at least the upper part of it, is of Pennsylvanian age has frequently been considered. The Quadrant sandstone is certainly calcareous at its base, and also fossiliferous. The only fossils directly associated with the Pentremites found by the writer at Old Baldy are *Hustedia mormoni* and *Spiriferina kentuckiensis*, both of which indicate an Upper Carboniferous horizon. We must therefore cease to think of the genus Pentremites as becoming extinct with the close of the Mississippian, and recognize it as extending, at least in the Rocky Mountains and in Arkansas, over into Pennsylvanian time.

I would suggest the advisability of comparing species of blastoids not solely by means of written descriptions, but with the help of actual measurements. Such measurements are at the same time both a check upon the description, and in some ways a shorthand expression of it. Frequently, disconnected measurements have been given in descriptions of species but until Mather's paper no recognized set of measurements had been used. It will be seen, however, that mere listing of the actual measurements of blastoids will lead to endless confusion unless we have a datum point to start from. I suggest, in this connection, that actual measurements of Pentremites be adjusted to a standard height for each specimen of twenty millimeters. Obviously the measurements of adult forms only should be adjusted in this manner, and each investigator must use his own discretion in rejecting specimens too young to be treated. Individual variations within a given species may tend to detract from the advantage of this system of tabulating the characteristics of Pentremites, but, on the whole, I feel confident that such a system will be of great help in separating the species of this genus.

For Schizoblastus, I have used a standard of ten millimeters, fearing lest further magnification should multiply unavoidable errors in measurements. For larger specimens than ours, twenty millimeters may prove to be better.

The following pages contain a list of all blastoids which have, to the knowledge of the writer, been reported from the Rocky Mountains.

PENTREMITES SAXIOMONTANUS, sp. nov.

Plate **1**, fig. 1–6, 14.

Description.— Body of medium size, ovate, thickest at the base of the ambulacra. Basal portion obconical, prominent, occupying about a quarter of the length of the specimen. The radial plates are narrow, each with a markedly prominent angular median ridge below the bifurcation; that part of the radials between the ridges being perfectly flat. Each fork of the radials is slightly convex, thus making a median depression along each interambulacral area. The radials are ornamented with fine striae running parallel to the suture, ending against the ambulacral border, and apparently converging slightly towards the base. Deltoids very small, unornamented, short, and narrow. The interambulacral area shows only a slightly raised border, in some specimens none at all. The ambulacra extend to the thickest part of the body, about three quarters the entire length, enlarging constantly to near the summit; hence the sides are not subparallel.

Dimensions of three specimens[1] *in millimeters.*

Height	13.	14.	15.
Maximum diameter	9.	10.	12.
Length of ambulacral plates	9.	9.5	10.5
Maximum width of ambulacral area	3.8	3.5	4.
Length of deltoid plates	2.5	3.5	3.
Maximum width of deltoid plates	1.5	1.5	1.5
Average number of side-plates in 5 mm.	13.	16.	13.

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[1] These three specimens are figured on Plate **1**, in order, fig. 4, 1, and 14.

Dimensions of the three specimens adjusted to a height of 20 millimeters.

Height	20.	20.	20.
Maximum diameter	13.8	14.3	16.
Length of ambulacral area	13.8	13.6	13.7
Maximum width of ambulacral plates	5.8	5.	5.3
Length of deltoid plates	3.8	5.	4.
Maximum width of deltoid plates	2.3	2.1	2.

Formation and locality.— I collected this species from the limestone member of the Quadrant formation at Old Baldy, near Virginia City, Montana, and at Squaw Creek off the West Gallatin River.

Pentremites symmetricus (Kaskaskia limestone of Kentucky) most nearly resembles *Pentremites saxiomontanus*, but its interambulacral areas are concave; in *Pentremites saxiomontanus* they are flat. The base of the latter species is not so stout, and the summit has a smaller area. The lesser prominence of the median ridges on the radials in *Pentremites symmetricus*, too, is a marked difference. The angle made by the sutures between the deltoid and radial plates in *Pentremites symmetricus* is obtuse, in *Pentremites saxiomontanus* very acute.

Pentremites pyriformis (Mississippian of Alabama, Tennessee, Kentucky, Illinois, Indiana, Missouri) is thickest in the middle and rounded in outline, while *Pentremites saxiomontanus* is decidedly angular. The deltoids are smaller in *Pentremites pyriformis*, and the basal portion is more elongate.

One of the specimens, as etched from the matrix, showed a very slender column, which would help to distinguish it from *Pentremites gemmiformis* (Kaskaskia of Illinois). The latter species possesses a rim around the ambulacral area and sixteen side-plates in five millimeters.

In *Pentremites elegans* (Millstone grit of Kentucky, Maxville limestone of Ohio) the deltoids are small, occupying but one sixth the length of the body. The ambulacra are, relatively, considerably shorter than those of *Pentremites saxiomontanus*, and in outline too much rounded below. Moreover in *Pentremites elegans* there are twenty-one side-plates in five millimeters.

PENTREMITES DIVERGENS, sp. nov.

Plate 1, fig. 7–10.

Description.— Small, thickest at the base of the ambulacra. Width and height subequal, the body being slightly higher than wide. Basal portion obconical, occupying about one third the length of the specimen. The basal plates are obscured in the type. The radials are prominently angular below the ambulacra, forming a longitudinal ridge extending from the base of the ambulacra to the basals; the spaces between these ridges are concave. The interambulacral areas narrow rapidly upwards and are depressed along each median suture; there is no rim bordering the interambulacral areas. The deltoids are small, less than a quarter the length of the whole body, acuminate, the tip somewhat incurved towards the oral aperture. Oral opening and spiracles large, shape uncertain. The ambulacral areas enlarge rapidly upwards, the lower end distinctly rounded in outline, and not angular. There are from fifteen to sixteen side-plates in the space of five millimeters.

Dimensions of two specimens in millimeters.

Height	11.	—
Maximum diameter	10.	8.5
Length of ambulacral area	7.5	6.25
Maximum width of ambulacral plates	3.25	3.
Length of deltoid plates	2.5	1.5
Maximum width of deltoid plates	1.0	.5
Average number of side-plates in 5 mm	16.	15–16

Dimensions of the two specimens adjusted to a maximum diameter of 18 mm.

Height	20.	—
Maximum diameter	18.	18.
Length of ambulacral area	13.6	13.2
Maximum width of ambulacral plates	5.9	6.3
Length of deltoid plates	4.5	3.1
Maximum width of deltoid plates	1.8	1.1

Formation and locality.— The specimens were collected by the author from the limestone member of the Quadrant formation at Old Baldy.

This species can be distinguished from either *Pentremites altimarginatus* or *P. saxiomontanus* by its rotund form.

Pentremites cervinus (Mississippian of Alabama and Illinois) is more angular, especially below the ends of the ambulacra. In *Pentremites divergens* the deltoids are more than twice as long as wide, while in *Pentremites cervinus*, according to the figure they are only one half longer than wide, therefore less mucronate. The ambulacra expand very gradually toward their widest part.

Pentremites cherokeus (Mississippian of Alabama, Illinois, and Tennessee) is a larger form whose deltoids project above the oral aperture. The angles at the bases of the ambulacra are too prominent to be *Pentremites divergens*, and the interambulacral areas are deeply concave. Moreover *Pentremites cherokeus* is considerably thicker than high and the summit (including the deltoids) is two thirds as wide as the maximum thickness of the specimen.

Pentremites koninckanus (Mississippian of Indiana, Illinois, Iowa, Missouri) has much shorter ambulacra and deltoids.

Pentremites bradleyi (Carboniferous of Montana) has its ambulacra deeply excavated along the middle. In *Pentremites divergens* the ambulacra are scarcely grooved at all. The flat base of *Pentremites bradleyi* is the most distinguishing feature of the species. The latter species has nineteen side-plates in five millimeters, *Pentremites divergens* fifteen to sixteen.

Pentremites rusticus Hambach (Trans. Acad. sci. St. Louis, 1903, **13**, p. 54, fig. 15) has a subcylindrical body, with the upper portion of the interambulacral areas strongly elevated above the ambulacrals. The base is flattened or concave. This species was described by Hambach from the Chester limestone of Arkansas, and discovered by K. F. Mather, along with *Pentremites angustus*, in beds of Pennsylvanian age in Arkansas (Bull. Sci. lab. Denison univ., 1915, **18**, p. 101, pl. 3, fig. 3–6a).

This species takes its name from the widely diverging margins of the ambulacral areas.

PENTREMITES ALTIMARGINATUS, sp. nov.

Plate **1**, fig. 11–13.

This species, which includes the largest forms so far found at Old Baldy, is represented by four specimens, all of whose observable characteristics agree so closely that there can be no doubt that all belong to the same species.

Description.— Body ovoid, outline rounded, widest just below the middle, and above the base of the ambulacra. Summit flat, base obconical, the opposite sides converging at an angle of about 70°. The radial plates are stout, each fork nearly, if not quite, flat; the suture between adjacent radials slightly depressed. The deltoid plates are large, quadrangular, half as long as the ambulacral areas, and half as wide as long; not quite reaching the summit. The interambulacral areas are furnished with a high, sharply defined rim where they border upon the ambulacra. The ambulacra are about three quarters the length of the body, with sides diverging uniformly to near the summit; median food-groove distinctly depressed. Angular ridges are present on the radials directly below the ambulacra, but they are not prominent. The poral plates are directed upwards.

Dimensions of two specimens in millimeters.

Height	20.	20.
Maximum diameter	16.	15.
Length of ambulacral area	16.	15.
Maximum width of deltoid plates	4.5	5.
Length of deltoid plates	7.	—
Maximum width of deltoid plates	3.5	—
Average number of side-plates in 5 mm.	15.	15.

Formation and locality.— All the specimens are from the limestone member of the Quadrant formation at Old Baldy, near Virginia City, Montana.

Pentremites altimarginatus differs from *Pentremites conoideus* (Mississippian of Indiana, Illinois, Iowa, Missouri, and Montana) and *Pentremites angustus* (Chester limestone of Arkansas, Trans. Acad. sci. St. Louis, 1903, **13**, p. 53, fig. 14a–b, and Pennsylvanian of Arkansas, Bull. Sci. lab. Denison univ., 1915, **18**, p. 100, pl. 3, fig. 10–13a) in its more rounded form and in the two latter species the base is truncate and the long, narrow ambulacra extend almost the whole length of the body. *Pentremites angustus* has larger deltoid plates and an average of seventeen side-plates in five millimeters.

Pentremites burlingtonensis (Burlington limestone of Iowa) has "the base much depressed or having the form of a pentagonal dish" (Geol. survey Illinois, 1873, **5**, p. 461). The general outline is much too globose, and too wide above the middle. The ambulacra are also too long.

Pentremites chesterensis (Kaskaskia limestone of Illinois) has twelve side-plates in five millimeters. Moreover the deltoid plates project slightly above the apertures on the summit. It also differs from *Pentremites altimarginatus* in having long, comparatively narrow ambulacra, which do not taper downwards appreciably but appear to have subparallel sides.

Pentremites obesus (Millstone grit of Kentucky, Kaskaskia limestone of Illinois, Kentucky, and Missouri) resembles *Pentremites altimarginatus* in shape somewhat, but is a much larger form. Its ambulacra are rather shorter than in the specimens from Old Baldy, and the deltoids also are shorter.

Pentremites godoni (Subcarboniferous; distribution widespread) differs from this form in having a subtruncate base and ambulacra which extend nearly the whole length of the specimen. Moreover *Pentremites godoni* is stelliform in cross-section and *Pentremites altimarginatus* is not.

Pentremites robustus (Millstone grit of Kentucky) has all the sutures in the base depressed. The ambulacra are six sevenths the length of the specimen, and the sides are subparallel. It has eighteen side-plates in five millimeters. Our specimens are rather fragile, but in *Pentremites robustus* "all the main pieces composing the body are of remarkable thickness and strength" (Trans. Acad. sci. St. Louis, 1860, **1**, p. 630). Moreover there is no rim bordering the interambulacral areas.

Pentremites maccalliei Schuchert (Bangor limestone of Georgia) has twelve to thirteen side-plates in five millimeters while *Pentremites altimarginatus* has fifteen. The former species is very large and stelliform (Proc. U. S. N. M., 1906, **30**, p. 759–760).

The specific name of this form refers to the raised rim between the interambulacral areas and the ambulacra.

PENTREMITES BRADLEYI Meek.

Pentremites bradleyi Meek, Rept. U. S. geol. surv. Montana, Idaho, Wyoming, and Utah, 1873, p. 470. Hambach, Trans. Acad. sci. St. Louis, 1903, **13**, p. 56, pl. 5, fig. 7.

This species was originally described by Meek in 1873 in a footnote. His description follows. "A small species like *P. koninckianus*, Hall, but shorter below, and having its pseudambulacra more deeply excavated along the middle, with their pore pieces transverse." It remained for Hambach, in 1903, to supplement this meager and altogether insufficient description by the following words:— "Body small, obtuse, conical. Basal portion almost flat, and resembling that of *Pentremites conoideus* very much, but being more rounded and having a larger articulation surface for the column, in proportion to its size, than *Pentremites conoideus*. Ambulacra broad, excavated along the middle, and having rather narrow integumental plications, there being about twelve to one eighth of an inch. Deltoids visible externally. Genital openings as in all true Pentremites.

"This species was first described by Meek, but merely in a footnote, comparing it with *Pentremites koninckianus* = *conoideus* Hall. It differs from *Pentremites conoideus* in being more obtuse, with broader and more deeply excavated ambulacra than *Pentremites conoideus* in which the ambulacra are narrow, more rounded, and the surface plications coarser. The interambulacra are depressed more in *Pentremites conoideus* than in this species. It differs from *Pentremites godoni* in being not as round, with more depressed ambulacra, and in not having the sharp crest-like margin around the sinus.

"Geological formation and locality. Subcarboniferous on the divide between Ross Fork and Lincoln Valley, Montana. First mentioned in F. V. Hayden's Sixth Annual Report of the United States Geological Survey of the Territories, 1873, p. 470. Types in the Smithsonian Collection, numbered 24,529."

PENTREMITES CONOIDEUS Hall.

Pentremites conoideus Hall. Meek, Rept. U. S. geol. surv. Montana, Idaho, Wyoming, and Utah, 1873, p. 470.

This species was listed by Meek in 1873 among fossils collected in Carboniferous strata from the divide between Ross Fork and Lincoln Valley, Montana.

In 1905, Mr. Earl Douglass found a specimen which was identified by Dr. P. E. Raymond as *Pentremites conoideus*, in a decomposed limestone on Old Baldy. From the same stratum a large number of other fossils were obtained, all of them species characteristic of the Madison limestone. This specimen may be described as follows. The body is rather badly crushed, and lacks the entire apical portion, and one ambulacral area. When perfect the specimen must have been nearly one inch high, conical, with a flat base. The ambulacral areas are long, narrow, and convex, expanding only slightly towards the apex. The lancet-plate is prominent, narrow, occupying about one half the ambulacral area. Side-plates narrow, with minute pits for the insertion of the brachioles. The base is badly fractured, and the sutures of the basal plates are obscured. The fork-plates are large, deeply depressed along the sutures, and ornamented by fine striae which are to some extent parallel to the median suture of the interambulacral area. There are thirteen side-plates in five millimeters. The specimen is in the Carnegie Museum, Pittsburgh, Penn.

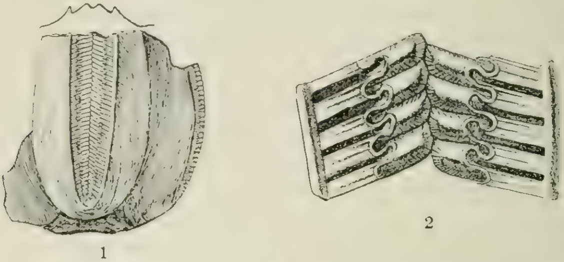

Fig. 1, 2. *Pentremites conoideus* Hall. A crushed specimen from the Madison limestone at Old Baldy, Mont. 1. The specimen. × $\frac{3}{2}$. 2. Detail of ambulacrum. × 10.

PENTREMITES GODONI Defrance.

Pentremites godoni? Defrance. Meek, Rept. U. S. geol. survey, Montana, Idaho, Wyoming, and Utah, 1873, p. 469, 470.

This species, or a closely related form, was noted by Meek in Carboniferous rocks at two localities in Montana, Old Baldy near Virginia City, and the Divide between Ross Fork and Lincoln Valley.

PENTREMITES SUBCONOIDEUS Meek.

Pentremites subconoideus Meek, Rept. U. S. geol. survey, Montana, Idaho, Wyoming, and Utah, 1873, p. 471. Hambach, Trans. Acad. sci. St. Louis, 1903, **13**, p. 38.

Meek devoted only a couple of lines to the description of *Pentremites subconoideus,* and placed them in a footnote. The description follows:— "A very small obconic species, much produced below the pseud-ambulacral areas, which are very short, or almost confined to the summit, as in *Codaster,* though it is a true *Pentremite.*" Hambach, in 1903, considered this form to be the young of *Pentremites pyriformis* ("*Pentremites subconoideus,* Meek, a young form of *Pentremites pyriformis*") though he gave no reason for this statement.

The specimens from which Meek described the species came from the Carboniferous at the Divide between Ross Fork and Lincoln Valley, Montana.

PENTREMITES SYMMETRICUS Hall.

Pentremites symmetricus Hall. Meek, Rept. U. S. geol. survey, Montana, Idaho, Wyoming, and Utah, 1873, p. 469.

After listing the species from the Carboniferous of Old Baldy, Montana, Meek wrote "As far as can be determined from the specimens, it seems to agree well with *Pentremites symmetricus.*"

SCHIZOBLASTUS HAYNESI, sp. nov.

Plate 1, fig. 15–20.

Description.— Body small, spheroidal, the greatest diameter exactly in the middle. Basal portion flat, no suggestion of concavity. Summit flat, its diameter rather less than half the maximum thickness of the body. The basal plates are nearly flat (maximum width three millimeters), ornamented by clearly defined ridges running parallel to the sutures. The radials are long, extending nearly the whole length of the body in side-view, ornamented, like the basals, by ridges which run parallel to the base, but diverge somewhat from their mutual suture; the ridges are occasionally interrupted so as to resemble rows of nodules. The diverging ridges on the interambulacral area occupy a leaf-shaped space, between which and the ambulacra are flattened linear areas ornamented by obscure low transverse ridges; this area rises next the ambulacra to a sharp ridge especially at the lower end where it is ornamented by a row of nodules rising from the side next the ambulacra and crossing over to the leaf-shaped area containing the longitudinal striae. Deltoids small, about as long as wide, somewhat flattened at their apices; they appear to be bounded towards the apical end by an angular suture, which is parallel to the lower suture, but this is in all probability merely an ornamentation. Above this line the deltoids are deflected towards the plane of the summit and somewhat hollowed out so as to simulate grooves. The ambulacra are long and narrow, sides parallel; in side-view occupying the whole height of the body; bordered by the high raised rim of the interambulacral area; the lancet-plate rises in a prominent ridge along the whole length of each ambulacrum. The food-groove is only slightly depressed. There are 28 side-plates in 5 mm. The anal opening is many times larger than any of the spiracles, and is confluent with the two adjacent spiracles.

Dimensions of three specimens in millimeters.

Height	6.75	5.5	5.25
Maximum diameter	7.	5.5	5.
Length of radial plates	6.	4.	?
Maximum width of radial plates	3.5	2.75	2.5
Length of deltoid plates	1.5	1.5	1.75
Maximum width of deltoid plates	1.5	1.5	1.5
Average number of side-plates in 5 mm.	28.	28.	28.

Dimensions of the three specimens adjusted to a height of 10 millimeters.

Height	10.	10.	10.
Maximum diameter	10.4	10.	9.5
Length of radial plates	8.9	7.3	?
Maximum width of radial plates	5.2	5.	4.8
Length of deltoid plates	2.2	2.7	3.3
Maximum width of deltoid plates	2.2	2.7	2.86

Formation and locality.— The specimens are from the Madison limestone of Old Baldy and of Squaw Creek, Montana, collected by Dr. W. P. Haynes and the writer.

This species differs from *Schizoblastus lotoblastus* (Subcarboniferous of Arizona and Idaho) in having a base not concave and in being globose, while in *Schizoblastus lotoblastus* the form is subelliptical in outline. Moreover the latter form is distinctly pentalobate at the base.

Schizoblastus granulosus (Keokuk group of Illinois) has a deeply concave base. In *Schizoblastus potteri* (Burlington limestone of Iowa) the forked pieces are short, only one quarter the length of the body. There is also a hook-like projection at the apex of the ambulacral field.

Schizoblastus sampsoni (Chouteau limestone of Missouri) has 18 side-plates in 5 mm. Its height is one fifth greater than its width, and there is a deep groove running the whole length of the ambulacra; in *Schizoblastus haynesi* the food-groove is only slightly depressed. The lateral expansion of the deltoids in *Schizoblastus haynesi* is one quarter the length of the body. On the whole *Schizoblastus haynesi* resembles *Schizoblastus sampsoni* more than any other species, especially in external ornamentation.

SCHIZOBLASTUS LOTOBLASTUS (White).

Granatocrinus lotoblastus White, Prelim. rept. inv. foss., 1874, p. 15; Rept. U. S. geog. surv. west 100th merid., 1879, 4, p. 80, pl. 5, fig. 3a, b; Bull. U. S. geol. and geog. surv. terr., 1879, **5**, p. 212.
Schizoblastus lotoblastus Weller, Bull. 153, U. S. G. S., 1898, p. 550.

White reported this species originally from Ewell's Spring, Arizona, but later identified it, with some doubt, from the Teton range, near the headwaters of the Teton River, just west of the common boundary of Idaho and Wyoming.

BRACHIOPODA.

CAMAROPHORIA OBESA, sp. nov.

Plate **2**, Fig. 13–24.

Description.— Shell small, subglobular in form, subcircular to subpentagonal in outline, longer than wide, wider than thick. Both valves are strongly convex; the pedicle-valve is the more strongly arched longitudinally, the brachial valve transversely. In the pedicle-valve the beak is prominent and overhangs the brachial valve considerably. There is a distinct but not strongly marked sinus on the pedicle-valve, within which is a raised median plication. On either side of the sinus are two plications, only the pair bordering the sinus achieving any prominence; occasionally the only evidence of the outer plication is a sinuosity in the lateral margin. The brachial valve is characterized by a short and not prominent fold divided by a median furrow. On each side there may be one or two short plications. The fold, sinus, and plications on both valves are short, not extending one half the length of the specimen.

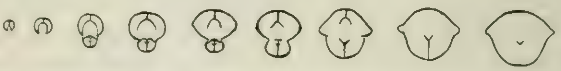

Fig. 3. Nine serial sections of the rostral portion of a specimen of *Camarophoria obesa* Clark. Natural size.

Internally, the pedicle-valve shows a pair of dental lamellae near the beak, supported by a median septum. The lamellae are continued anteriorly into a spondylium, well raised from the floor of the valve. The brachial valve has a slightly longer median septum supporting both hinge-plate and cruralium. The hinge-plate is short, and the cruralium extends a short distance beyond the septum.

The surface of the valves is unornamented save for lines of growth placed at irregular intervals.

This species resembles somewhat *C. explanata* (McChesney) which occurs in the Chester group of the Mississippi Basin. That species, however, is wider than long, has more prominent plications, and a broader and, indeed, very wide fold and sinus. *C. obesa* has a much more prominent beak.

Horizon and locality.— Professor J. B. Woodworth and the writer have collected this species from the Madison limestone at Old Baldy, Montana.

AXIODEANEIA, gen. nov.

Description.— Shells subovate to triangularly subovate in outline, the valves subequally convex, the mesial fold and sinus slightly developed or obsolete. Both valves marked by broad, rounded or subangular plications; when the surface is well preserved it is marked by fine radiating striae. In the pedicle-valve the hinge-teeth are small and are supported by slender, vertical, dental lamellae. In the brachial valve a well-defined median septum is present in the rostral portion of the valve, and is divided anteriorly to form a V-shaped crural cavity; the hinge-plate is divided, the inner margin of each lateral portion being supported by one of the lateral walls of the crural cavity. No cardinal process is present.

It will be seen that Axiodeaneia has the external characteristics of Rhynchotetra with the internal arrangements of Paryphorhynchus.

AXIODEANEIA PLATYPLEURA, sp. nov.

Plate 2, fig. 25–32.

Description.— Shell narrowly subtriangular, nearly twice as long as wide, greatest width one third the length from the anterior end. The sides are flat, two thirds the length of the shell, perpendicular to the plane of the valves, converging toward the beaks, giving the shell a distinctly wedge-shaped appearance. There is no hinge-area. The beak of the pedicle-valve projects beyond the brachial valve slightly. The valves are subequally convex from beak to anterior end; the brachial valve is well rounded from side to side, the pedicle-valve being nearly flat. Both valves are strongly plicated, with the anterior border deeply dentate. There are usually eight plications on the pedicle-valve and nine on the brachial; on both valves the lateral plications become obsolete towards the beaks. The pedicle-valve is marked by a strong median furrow, corresponding to which in the brachial valve is the strong median plication. The plications are subangular at the anterior end; the furrows are wide and rounded. In well-preserved specimens the whole surface is covered with fine radiating striae. Concentric markings are present, but indistinct.

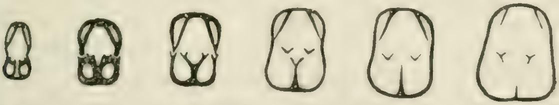

FIG. 4. Six serial sections of the rostral portion of a specimen of *Axiodeaneia platypleura* Clark. × $\frac{4}{3}$.

Internally the pedicle-valve possesses two strong dental lamellae which become free from the valve at their lower end slightly in front of the articulated portion of the valves; then rapidly diminish in length and become obsolete at about one third the length of the shell from the beak. The brachial valve shows a stout median septum which, according to Dr. Haynes's drawings, is formed by the fusion of two mutually convex septa each supporting the hinge-plate. The median septum is divided, forming a large crural cavity, each fork supporting a branch of the hinge-plate. The crural processes seem to be thrown off from both the hinge-plate and the fork of the median septum, so that each process is concave towards the pedicle-valve. None of the dental lamellae, crural processes or median septum extends beyond one third the length of the shell from the beak.

The dimensions of a specimen of average size are as follows:—

Length	26 mm.
Width	16 mm.
Thickness	14.5 mm.
Angle between sides	57°
Plications on pedicle valve	8
Plications on brachial valve	9

The species has been found in quantity in the Madison limestone at Old Baldy Montana, and, by the writer, near Cherry Creek Basin. Entire, free specimens are not common and frequently the shells are crushed. The condition of the beaks is seen only in two very nearly perfect specimens, but in these the pedicle-opening is obscured by damage. Natural casts or moulds of the interior have not been found, and what is known of the interior has been gained by a study of sections drawn by Dr. W. P. Haynes while grinding down the beaks.

This form cannot be mistaken for any other species in the collections from southwestern Montana except perhaps *Camarophoria ringens* (Swallow), identified by Girty from the Yellowstone National Park. I quote from Swallow's description:— "sinus wide and shallow, containing about eight plications..... Surface marked with about fourteen large plications on each valve. Length 1.90; breadth, 1.43; thickness, .99" (Trans. Acad. sci. St. Louis, 1860, **1**, p. 653). *Camarophoria ringens* is therefore a much broader form, with a sinus and more plications than *Axiodeancia platypleura* which has no sinus at all. The small number of plications, the prominent median plication and furrow, the narrow triangular form and the flat sides are sufficient to distinguish this species from any other known form.

GIRTYELLA WOODWORTHI, sp. nov.

Plate **2**, fig. 1–12.

Description.— Shell small, subpentagonal in outline, longer than wide, greatest width in the middle or somewhat back of the middle. The anterior margin is often concave. Both valves are moderately convex. Longitudinally the pedicle-valve is the more strongly arched, transversely the brachial. The pedicle-valve has a median sinus which begins about six millimeters from the umbo and is low, broad, and rounded. The sinus is not conspicuous in shells less than nine or ten millimeters long. The brachial valve possesses a still more shallow, wide sinus, within which, throughout the length, there is a low, rounded fold. Faint lines of growth occur on each valve.

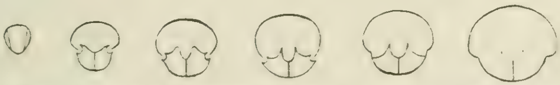

FIG. 5. Six serial sections of the rostral portion of a specimen of *Girtyella woodworthi* Clark. × 2.

Internally, the dental lamellae of the pedicle-valve are very short, scarcely extending beyond the beak. In the brachial valve, the concave hinge-plate, supported by a median septum is continued for about one third or one quarter the length of the specimen. The socket-plates are deflected upwards from the margins of the valve to meet the hinge-plate, and are continued anteriorly to form the crural processes. The median septum continues to about one third the length of the valve.

This form is more robust and more rounded along the anterior margins than *G. brevilobata* Swallow which occurs in the Chester formation of the Mississippi Valley. The latter has a well-developed mesial sinus in the pedicle-valve, which is much narrower than the sinus in the corresponding valve of *G. woodworthi*. In the brachial valve of *G. brevilobata* the mesial fold in the sinus occurs only at the anterior end, while in *G. woodworthi* it extends all along the sinus.

Horizon and locality.— This species has been collected by Professor J. B. Woodworth and the writer in the Lower Carboniferous (Madison) limestone at Old Baldy, Montana.

Lower and Upper Carboniferous in Montana.

One of the problems in the study of the western Carboniferous is to determine where the line between Upper and Lower Carboniferous should be drawn. If fossils are to be used in reaching a decision it will be necessary to rely mostly upon brachiopods, for not only do they include the great majority of all Carboniferous fossils, at least in southwestern Montana, but the species are for the most part quite easily identified. As a contribution toward the solution of this problem I append lists containing all the brachiopods so far reported from Old Baldy, Montana. They are separated into three groups; the first contains those which occur in the Lower Carboniferous, the second contains those which occur in the Upper Carboniferous, and the third contains those which are known to occur in both Upper and Lower Carboniferous. In compiling these lists I have used the published lists of Meek[1] and Douglass,[2] and also the collections in the Museum of Comparative Zoölogy made by Professor Woodworth and his students in the Harvard Summer School. My own collections were made while I was a member of the Harvard Summer School in 1915. Weller's Bibliographic index of North American Carboniferous invertebrates[3] was the chief source of information regarding geologic ranges. There is much valuable information as to geologic ranges in Girty's Carboniferous formations and faunas of Colorado.[4]

Brachiopods occurring in the Lower Carboniferous.

- Schizophoria resupinata (Martin).
- Leptaena analoga (Phillips).
  - rhomboidalis (Wilkins).
- Schuchertella crenistria (Phillips).
  - inflata (White and Whitfield).
- Orthotetes inaequalis (Hall).
- Chonetes loganensis Hall and Whitfield.
  - ornatus Shumard.
- Productus altonensis Norwood and Pratten.
  - flemingi var. burlingtonensis Hall.
  - laevicostus White.
  - parviformis Girty.

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[1] Meek, 1873, Sixth Ann. rept., U. S. geol. surv., of territories for 1872, p. 468–470.

[2] Douglass, 1905, Annals Carnegie mus., **3**, p. 417–420.

[3] Weller, 1898, Bull. 153, U. S. G. S.

[4] Girty, 1903, Prof. paper 16, U. S. G. S.

Camarophoria ringens (Swallow).
    obesa Clark.
Camarotoechia metallica (White).
    herrickana Girty.
Axiodeaneia platypleura Clark.
Dielasma utah Girty.
Girtyella woodworthi Clark.
Spirifer centronatus Winchell.
    centronatus var. semifurcatus Girty.
    grimesi Hall.
    cf. striatus (Martin).
    peculiaris Shumard.
Reticularia cooperensis (Swallow).
    setigera (Hall).
Martinia rostrata Girty.
Spiriferina spinosa (Norwood and Pratten).
    solidirostris Winchell.
Athyris lamellosa Leveille.
Eumetria vera (Hall).
Cleiothyridina crassicardinalis (White).
    crassicardinalis var. nana (Girty).
Composita claytoni (Hall and Whitfield).
    madisonensis Girty.

Brachiopods occurring in the Upper Carboniferous.

Derbya crassa (Meek and Hayden).
Chonetes flemingi Norwood and Pratten.
Productus costatus Sowerby.
    inflatus McChesney.
    nebrascensis Owen.
    punctatus (Martin).
Marginifera haydenensis Girty.
    muricata (Norwood and Pratten).
Pugnax rockymontanus (Marcou).
Dielasma bovidens (Morton).
Spirifer rockymontanus Marcou.
Squammularia perplexa (McChesney).
Spiriferina kentuckiensis (Shumard).
    octoplicata (Sowerby).
    pulchra (Meek).
    spinosa (Norwood and Pratten).
Hustedia mormoni (Marcou).
Cleiothyridina orbicularis (McChesney).
Composita subtilita (Hall).

Brachiopods occurring in the Upper and Lower Carboniferous.

Productus cora d'Orbigny.
    gallatinensis Girty.
    prattenianus Norwood (? = P. cora).
    scabriculus (Martin).
    semireticulatus (Martin).

PLATE 1.

PLATE 1.

(All the specimens figured are in the Museum of Comparative Zoölogy).

Pentremites saxiomontanus Clark.

Fig. 1–3 are three views of the type, M. C. Z. 1001, from Squaw Creek, Montana. × $\frac{4}{3}$.

Fig. 4–6 are similar views of a less well-preserved specimen from the Quadrant limestone at Old Baldy, Montana. × $\frac{4}{3}$.

Pentremites divergens Clark.

Fig. 7–10 are three views of the type M. C. Z. 1002. Fig. 7 shows very clearly that the specimen is thickest at the base of the ambulacra. One side is unfortunately damaged.

Fig. 10 is a single view of a smaller specimen, also incomplete, and shows the sutures between a deltoid and two adjacent ambulacral plates. × $\frac{4}{3}$. From the Quadrant limestone at Old Baldy, Montana.

Pentremites altimarginatus Clark.

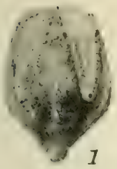
Fig. 11–13. Three views of the type, M. C. Z. 1003, which is very well preserved though fragile. × $\frac{4}{3}$. From the Quadrant limestone at Old Baldy, Montana.

Fig. 14. A fragment of Quadrant limestone from Old Baldy, Montana. It contains
Center, *Pentremites saxiomontanus* Clark.
Right, *Pentremites altimarginatus* Clark.
Left-center, *Hustedia mormoni* Marcou.
Top, *Spiriferina kentuckiensis* Shumard. × $\frac{4}{3}$.

Schizoblastus haynesi Clark.

Fig. 15–17. Three views (including basal) of a small rather poorly preserved specimen. × 4.

Fig. 18–20. Three similar views of the type M. C. Z. 1004. × 4.
Both from the Madison limestone, Squaw Creek, Montana.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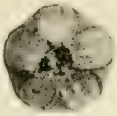
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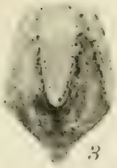
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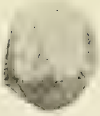
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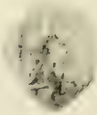
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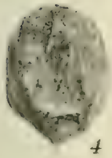
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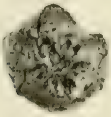
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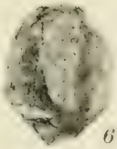
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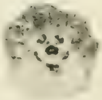
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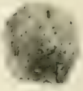
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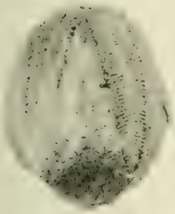
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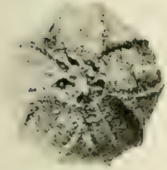
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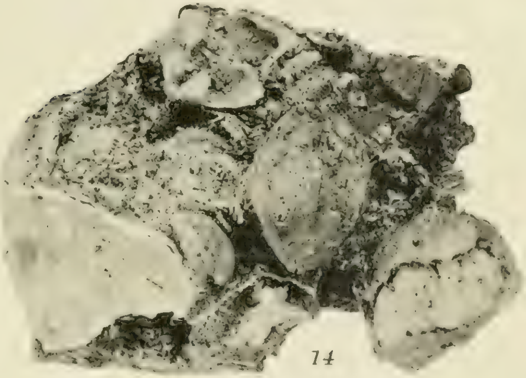
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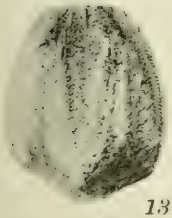
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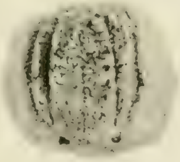
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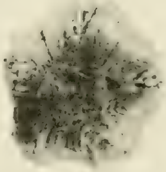
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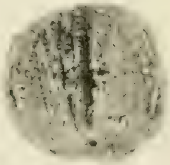
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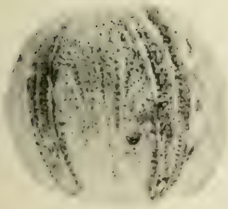
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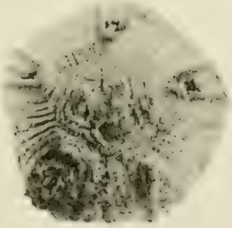
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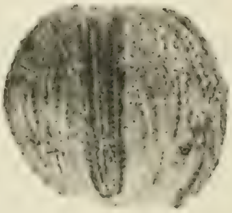
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PLATE 2.

PLATE 2.

(All the specimens figured are in the Museum of Comparative Zoölogy).

Girtyella woodworthi Clark.

Fig. 1–12. Brachial, pedicle, anterior, and lateral views of three specimens. 9–12 is the type M. C. Z. 8533. × $\frac{4}{3}$. From the Madison limestone at Old Baldy, Montana.

Camarophoria obesa Clark.

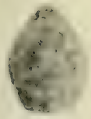
Fig. 21–24. Brachial, pedicle, anterior, and lateral views of the type, M. C. Z. 8531. × $\frac{4}{3}$.

Fig. 13–16 and 17–20. Similar views of other specimens. From the Madison limestone at Old Baldy, Montana. × $\frac{4}{3}$.

Axiodeaneia platypleura Clark.

Fig. 29–32. Brachial, pedicle, lateral, and anterior views of the type, M. C. Z. 8532. × $\frac{4}{3}$.

Fig. 25–28. Similar views of a slightly larger specimen. × $\frac{4}{3}$. From the Madison limestone at Old Baldy, Montana.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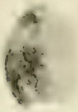
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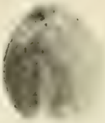
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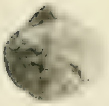
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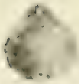
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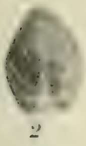
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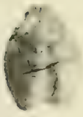
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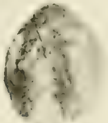
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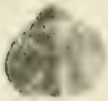
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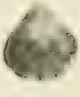
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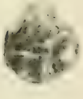
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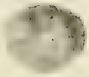
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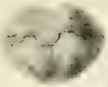
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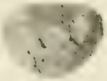
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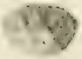
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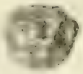
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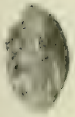
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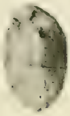
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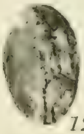
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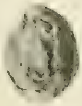
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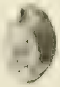
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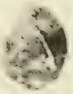
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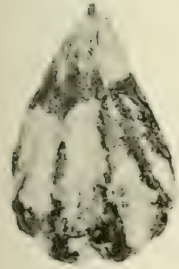
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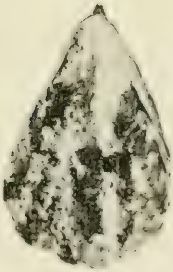
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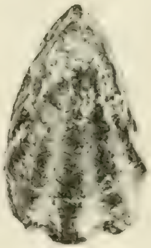
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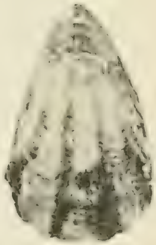
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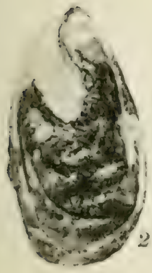
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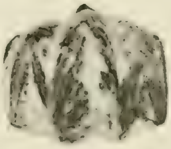
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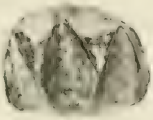
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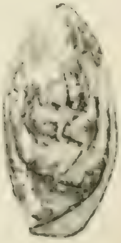
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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXI. No. 10.

A NEW SPECIES OF PERIPATUS FROM THE MOUNTAINS OF NORTHERN PERU.

By Charles T. Brues.

With One Plate.

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM.
September, 1917.

No. 10.— *A New Species of Peripatus from the Mountains of Northern Peru.*

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, No. 131.

By Charles T. Brues.

On a recent trip to Peru, Mr. G. K. Noble, Zoölogist of the Expedition to Peru, under the joint auspices of the School of Tropical Medicine and the Museum of Comparative Zoölogy, secured six fine specimens of Peripatus which represent an hitherto undescribed species. These were obtained at Tabaconas, near Huancabamba at an altitude of about 6000 feet. Tabaconas is on the third or eastern range of the Cordilleras less than 100 miles south of the Ecuadorian boundary and some 200 miles south of Cuenca in Ecuador where *Peripatus cameranoi* was discovered by Festa over twenty years ago. The new species is closely related to this Ecuadorian form, and also to several others from the same region, but I feel satisfied that it is specifically distinct from all of them.

The specimens were found by Mr. Noble while searching for reptiles beneath stones along the roadside and occurred in a moderately dry locality. From observations which he made on the general fauna, he regards the area inhabited by the Peripatus as distinctly a narrow extension of the Ecuadorian region and not similar to the other Peruvian places either due east or west where he collected in travelling inland from the arid coastland.

The species falls into the group of andicolous species as defined by Bouvier and separated as the subgenus Oroperipatus by Cockerell in 1908. Since then Oroperipatus has been elevated to generic rank by Clark. The new form may be known as:

Peripatus (Oroperipatus) peruvianus, sp. nov.

Size and form. All of the females, four in number are rather stoutly built, broadest just before the middle and gradually narrowed behind. They range in width from 7.5 to 9.0 mm., but as they are undoubtedly somewhat contracted, must have been more slender in life. One is quite broad anteriorly and more slender than the others posteriorly, but the approximation of the anterior pairs of legs shows this to be due to a contraction of the anterior half of the animal. There is very little variation in length as can be seen from the following measurements of all four female specimens.

	Length	Width	Legs
Type	59.0 mm.	9.0 mm.	37 pairs
Paratype	56.0 mm.	8.0 mm.	36 pairs
Paratype	55.0 mm.	7.5 mm.	36 pairs
Paratype	61.0 mm.	8.5 mm.	37 pairs

Legs. The number of pairs of legs varies from 36 to 37 in the female, two having the former and two the latter number. In the male, as shown by two specimens there are 34 pairs. Each leg has five well-developed creeping pads, the fifth usually considerably narrower than the fourth and occasionally somewhat reduced in length, although usually almost as long as the fourth. The first is broader and the three following of about equal width as a rule, although frequently the fourth is distinctly narrower and sometimes scarcely wider than the fifth. The nephridial tubercles of the fourth and fifth pairs of legs (Fig. 1) are nearly included in the third creeping pad which is very deeply emarginate, but not completely divided by them; the fourth pad is distinctly emarginate, but not deeply excavated along its distal edge opposite the tubercle. There are four pedal papillae on each leg, very rarely five in three of the four specimens, while the fourth shows on a considerable number of the anterior legs five well-developed papillae. The fifth papilla is rarely as large as the others, and sometimes occurs between the pair on the anterior or posterior edge of the foot, or either above or below them. Bouvier has regarded the presence of extra papillae on certain legs as a specific character, but it is evident at least in the case of the

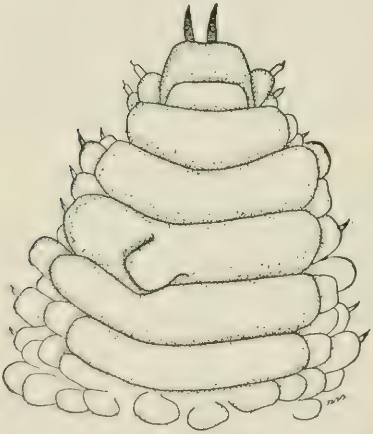


Fig. 1. - *Peripatus peruvianus* Brues. Nephridial tubercles of the fourth pair of legs.

present form that it must represent, to some extent at least, individual variation. While I cannot be sure that more of the examples show no legs with five papillae, it is very evident that one of them differs quite conspicuously from the others in this respect.

Integument. On each body-segment there are two body-folds which are incomplete, terminating about halfway between the median line and the base of the legs. The alternate body-folds differ slightly but regularly in width. This difference is slight and might easily be overlooked, but their papillae accentuate the variation since the larger papillae of alternate folds vary considerably in size. Thus on the broader folds the largest papillae are nearly twice as large as those on the narrower folds although there is practically no difference in the size of the small primary papillae on alternate folds. The largest papillae have an evenly rounded or slightly transversely oval base and are about as high as broad, with their nipple-shaped apex short and acute. The smaller primary papillae number most commonly three between a pair of large ones; not infrequently however, especially on the narrower folds only two occur; very rarely there are four, and occasionally five, in which case the middle one is nearly always markedly enlarged and the arrangement approaches that where there are two small ones between a pair of large ones. Aside from this very sparse scattering of medium sized papillae there is no tendency for any intergradation between large and small papillae. Accessory papillae are almost entirely absent; most of the body-folds show none at all, and an occasional fold one or two of very small size toward the edge of the fold.

Color. In life, according to Mr. Noble, the body is uniformly deep brown in color with a distinct yellowish band forming a collar behind the antennae. After nearly a year in alcohol, the band has lost its original color and shows as a paler area, almost white and very conspicuous in one specimen, and less noticeable in the others; in one especially, it is only slightly evident. It is quite broad, including from 17 to 23 body folds. The alcoholic specimens have also developed quite conspicuous body-markings which show as a zig-zag line extending along each side of the body halfway between the legs and median line, the angulations extending laterally opposite each leg and medially between the legs. Sometimes a distinct dark streak extends downward toward each leg. Between the darker markings and excepting the dark dermal papillae, the integument is greatly bleached and is of a dirty yellowish lilac tinge both above and below and on the legs.

Mandibles. (Fig. 2.) The mandibles have two well-developed accessory teeth and a less prominent but more heavily chitinized third one. The blade bears seven or eight denticles, the last two or three of the series much smaller in size.

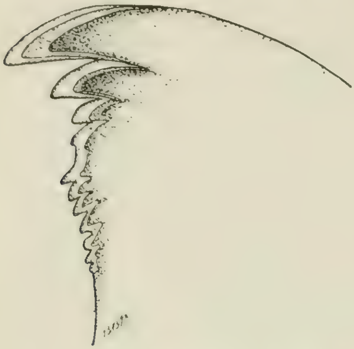


Fig. 2.— *Peripatus peruvianus* Brues. Mandible.

Type. M. C. Z. 314. Described from the type, three female paratypes, M. C. Z. 315–317, and two males, M. C. Z. 318–319, Tabaconas, near Huancabamba, Peru, August, 1916. G. K. Noble.

Relationships. The present form is quite closely similar to several others already known from Ecuador and western Colombia, and finds a place in the group of species from this region, the members of which have been carefully studied and described by Bouvier (Ann. sci. nat. Zool., 1907, sér. 9, **2**, p. 80–119). It is, however, readily distinguishable from all of them by anatomical characters, and must I think rank as a species rather than as a subspecies, particularly as it is difficult to associate it with any single described form to the exclusion of others.

By the alternation in width of the body-folds, the presence of *five* pedal papillae on some of the legs and the large number of legs, *P. peruvianus* falls at once into the group which includes *P. ecuadorensis*, *P. lankesteri*, *P. tuberculatus*, *P. quitensis*, and *P. cameranoi*.

P. ecuadorensis is at once distinguished from all the others including the present new species by the absence of segmentally arranged incomplete dermal folds. It differs from *P. peruvianus* also by its more numerous legs and by the fact that smaller dermal papillae are much more numerous between each pair of large papillae. *P. lankesteri* is more difficult to separate from *E. peruvianus*, but in the arrangement of the integumentary papillae is very different. The former possess numerous accessory papillae which are almost entirely absent in the latter. *P. tuberculatus* has the accessory papillae more numerous and is consequently less like *P. peruvianus* in this respect, it differs also in possessing the rudiment of a sixth creeping pad on the foot and the presence of only four pedal papillae on all the legs. *P. quitensis* has not been very accurately described (*cf.* Bouvier, *t. c.*, p. 110), and evidently resembles the present species closely. It has however, 36 pairs of legs in the male instead of 34 and from Bouvier's figure (*l. c.* p. 111, fig. 59) the papillae are evidently of much more nearly equal size, especially on the alternately narrower dermal folds; also the nephridial tubercle of the fourth pair of legs completely bisects the third creeping pad, which is not the case in *P. peruvianus.* The last previously described species of this group *P. cameranoi* is not very well known and occurs in a part of Ecuador which is close to the portion of Peru in which *P. peruvianus* was collected. Nevertheless the two seem to be distinct. In *P. cameranoi* the primary papillae are of rather variable size, but none are remarkably larger than the others whereas in *P. peruvianus* such is by no means the case. Also the Ecuadorian species has only four creeping pads with the vestige of a fifth and the nephridial tubercle of the fourth and fifth legs bisects completely the third creeping pad.

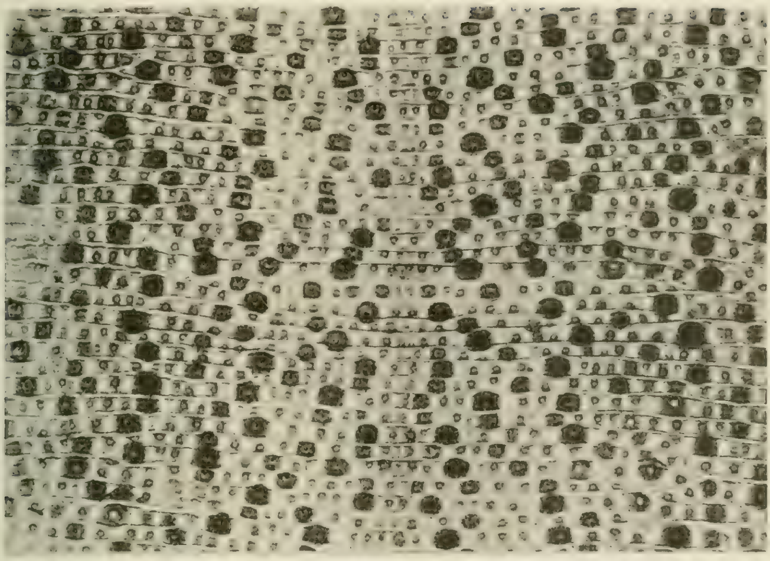
From the foregoing comparisons it appears that while *P. peruvianus* is closely related to a number of other species from the same region, it can not be regarded as conspecific with any of them.

EXPLANATION OF THE PLATE.

EXPLANATION OF THE PLATE.

Peripatus peruvianus Brues.

Fig. 1.— Integument, showing an area on each side of the median line.
Fig. 2.— A smaller area of the integument to the right of the median line.



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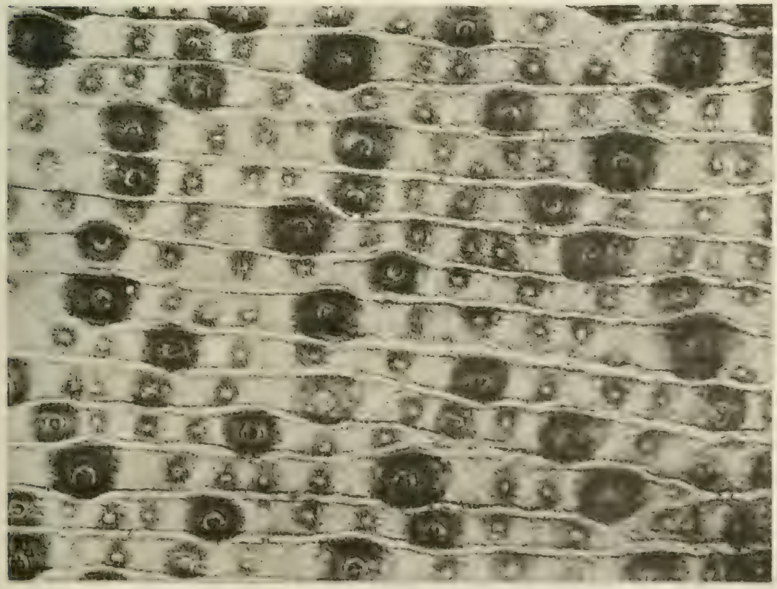

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
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BIRDS FROM THE NORTHERN COAST OF THE DOMINICAN REPUBLIC.

By James L. Peters.

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No. 11.— *Birds from the Northern Coast of the Dominican Republic.*

By James L. Peters.

Introduction.

During the winter of 1916 I had the pleasure of making an ornithological reconnaissance of the north coast of the Dominican Republic in the interests of the Museum of Comparative Zoölogy.

Landing at Monte Cristi on February 6, I remained there until February 11. On that date, accompanied by two other Americans, I went by automobile to Valverde, forty-five miles up the Yaqui River, where we took horses and proceeded up the valley of the Mao River to Bulla, arriving there about nine in the evening, having picked our way over the rocky trail by the light of a half moon.

Unfortunately circumstances compelled us to return the next morning before we had time to reach more than the outskirts of the pine forests which grow on the hills above Bulla. Arriving at Monte Cristi early in the morning of February 14, work was continued there until February 23 when I took the Clyde Line boat for Puerto Plata, sixty miles to the eastward.

The next collecting locality was Sosúa, a small village about fifteen miles east of Puerto Plata where the Sosúa Plantations Company is engaged in growing bananas.

I remained there until March 3, when accompanied by Sr. E. J. Cambier of Puerto Plata a pack-trip took us forty miles eastward along the coast to Cabrera, and from there about twenty miles southwestward into the interior as far as Arroyo Savanna.

During the trip we stopped at the following localities:

Gaspar Hernandez, March 3 and 13.
Rio San Juan, March 4 and 12.
Cabrera, March 5, 7 and 11.
Arroyo Salado, March 6.
Arroyo Savanna, March 8 and 9.
Los Toritos, March 10.

Returning to Sosúa, March 14, I remained there until the date of my departure from the island, April 11, with the exception of three days, March 24–26, spent at Choco, a small settlement in the hills a few miles south of Sosúa.

Although Santo Domingo is the oldest known land in the western hemisphere its bird-life has never received the study that has been accorded the other islands of the Greater Antilles. The first published accounts (Historia General y Natural de las Indias, Servilla, 1535), are by Gonzalo Fernandez de Oviedo y Valdés who accompanied Columbus on all his voyages.

Book XIV Chapter I, contains a description of a Tropic bird (*Phaëthon catesbyi Brandt*) met with on the voyage between Spain and the new world. Thus the Yellow-billed Tropic bird has the distinction of being the first new world species mentioned in literature.

Book XIV Chapter II, treats of birds found in "Española" (Santo Domingo) similar to those in Spain, mentioning many "torczáas" (doves) and tórtolas (Turtle Dove) of three or four kinds.... "and swallows larger than those of Spain lacking the red on the neck and head and with a forked tail" (doubtless *Progñe dominicensis*).

"And here there are also swifts in great numbers and large herons and lesser herons and falcons, agile and handsome, somewhat blacker than those of Spain and Italy. Also large and very beautiful goshawks and small eagles and guaraguaos [large hawks] the like of which are not in Spain. Then also there are barn owls and many kinds of water eagles as also .... gaviotas (terns) gavinas (gulls), calamones [the water hen of Spain = *Gallinula chloropus*] cernicalos [Sparrow Hawk] and carpinteros [woodpeckers]....There are many ansares [ducks] and these pass through the island in December. Other birds are found like those which sing so well in Spain, but their names are not known. But among these are ruyseñores [nightingales = mockingbirds].

"All these birds of which I have made mention in this chapter are natives of the island as well as of Spain, but on the mainland there are these and many others in abundance."[1]

Book XIV, Chapter IV deals with birds which are found in "Española" but not in Spain. Oviedo says, "There are many parrots, green, the size of or larger than doves..... The smaller ones with long tails....they call *xaxabes*...."The truth is that there are also some little green birds not larger than the *xilgueritos* [little linnets] of Castilla...."There are also some little birds as black as black velvet [probably *Anthracothorax dominicus*]...."There are other birds of many colors with different voices and different methods of singing but most of these birds have nothing peculiar to recall them to my memory."

---

[1] Madrid, 1851. Translations by Dr. Thomas Barbour and the author.

Oviedo devotes a whole chapter to *Dulus dominicus*, see p. 418. Another chapter has been devoted to "The nocturnal birds," *i. e.* nighthawks and owls, see p. 410–411.

Later the Spaniards appeared to lose their interest in science, and it remained for the French who settled the western portion of the island to take the first active interest in Haitian avifauna.

Among them was a M. Chervain who apparently collected a considerable number of both native birds and migrants which he sent to M. de Reamur. Brisson examined these specimens in de Reamur's collection and described and figured them in his Ornithologie, (Paris, 1760).

Both Linné and Gmelin based the names of Haitian species and North American migrants on the birds he thus described or figured.

The native species in question are:

Colymbus d. dominicus Linné, *Nomonyx dominicus* (Linné), *Falco s. dominicensis* Gmelin, *Anthracothorax dominicus* (Linné), *Tyrannus d. dominicensis* Gmelin, *Dulus dominicus* (Linné), *Progne dominicensis* (Gmelin), *Dendroica p. albicollis* (Gmelin), *Phoenicophilus palmarum* (Linné), *Tiaris o. olivacea* (Linné).

The names *Euphonia musica* (Gmelin) and *Coereba bananivora* (Gmelin) are based on Buffon, while *Holoquiscalus niger* (Boddaert) and *Icterus dominicensis* (Linné) are both based on Daubenton.

It is also of interest to note that the type-locality of *Ereunetes pusillus* (Linné), *Mniotilta varia* (Linné), *Dendroica d. dominica* (Linné), *D. p. palmarum* (Gmelin), and *D. c. caerulescens* (Gmelin) is Santo Domingo. The first three are based on Brisson; the last two on Buffon.

It is not until 1834 that we find any references in English. Then in the P. Z. S. there appears two notes on Haitian birds by J. Hearne Esq. The following year the Secretary of the Zoölogical Society of London exhibited a collection representing sixteen species of birds "formed in Haiti by J. Hearne Esq." The species, however, are not listed.

In 1857 Philip Lutley Sclater contributed to the P. Z. S. a Liste des Oiseaux rapportés et observés dans la Republique Dominicaine (ancienne partie Espagnogle de l'Ile St. Domingue ou d'Haiti) par M. A. Salle, pendant son voyage de 1849 à 1851. Salle's list contains 61 species all of them the commoner birds, although he includes "Rallus —, "petit. . . ." a bird not since found.

In 1866 Dr. H. Bryant published (Proc. Bost. soc. nat. hist. **11**, p. 89) A list of the birds of San Domingo with descriptions of some new species (*Myiarchus dominicensis*, *Blacicus hispaniolensis*, and *Loximitris dominicensis*). He lists 79 species.

In the introduction to his paper he mentions a collection, made near Port au Prince, Haiti by A. E. Younglove, in the Smithsonian Institution, and a small collection made by Mr. P. R. Uhler near Jeremie, Haiti, in the Museum of Comparative Zoölogy.

This last named collection, however, cannot be found in the M. C. Z., neither are there any entries in the catalogue by which it might be traced. There are a few common Haitian birds in the M. C. Z. taken at Port au Prince by Younglove between February and June, 1866, or after Bryant's visit.

From 1869 to 1871 Dr. W. M. Gabb was engaged in making a geological survey of the island for the Dominican Government. During the course of his survey he collected a few birds, among them the types of *Tolmarchus gabbi* (Lawrence) (*Pitangus gabbii* G. N. Lawrence, Ann. Lyceum nat. hist., N. Y., 1876, p. 288) and *Lawrencia nana* (Lawrence) (*Empinonax nanus* Lawrence, Ibis, 1875, p. 386).

From 1881 to 1883 Mr. C. B. Cory assisted by Mr. M. A. Frazar conducted an extensive collecting trip, during which time they covered the greater part of the island and obtained six species that previous collectors had not secured.

Jacana spinosa violacea (*Parra violacea* Cory, Bull. N. O. C., 1881, p. 129).

Calyptophilus frugivorus (*Phoenicophilus frugivorus* Cory, Journ. Bost. zoöl. soc., 1883, **2**).

Rupornis ridgwayi (ibid.).

Oidicnemus dominicensis (ibid.).

Microligea palustris (*Ligea palustris* Cory, Auk, **1**, p. 1).

Lamprochelidon scläteri (*Hirundo sclateri* Cory, ibid.).

From May to July, 1883, Dr. W. L. Abbott made a collection of about 175 skins from the eastern portion of the island, his collecting localities being Samana and La Cañita. This collection is now in the Academy of natural sciences of Philadelphia.

W. B. Tristram published a note in the Ibis (1884, p. 167) on a collection of San Domingo birds made by C. McGregor. Twenty-nine species are represented including the Flamingo and Spoonbill, not previously mentioned.

Then follows a gap of ten years in which no ornithological articles were published. During the winter of 1894–95 G. K. Cherrie collected extensively in the southern part of the island, basing on Santo Domingo City and penetrating to the center of the island. On this expedition he collected the types of *Hyetornis fieldi* Cory and *Elainia cherriei* Cory (Cory, Auk, 1895, **12**, p. 278).

An annotated list of his collection was published in 1896 (Cherrie, Contribution to the ornithology of San Domingo. Field Columbian museum, Ornithological series, **1**). It contains notes on 83 species including *Coccyzus americanus*, previously unrecorded.

During the winter of 1906–1907 Mr. A. H. Verrill collected in the vicinity of Samana Bay. The results of his trip Notes on the birds of San Domingo with a list of species, by A. E. and A. H. Verrill, were published in Proc. Acad. nat. sci. Phil., 1909, **61**, p. 352–366).

This list contains 112 species, including every single species up to that time described as being confined to the Island or recorded as a migrant. It includes a description of *Buteo tropicalis* which is undoubtedly *Buteo borealis jamaicensis*.

Since the preceding sketch of the ornithological history of Santo Domingo was written four cognate papers have been published: in the first Mr. J. H. Riley (Smithsonian misc. coll., 1 December, 1916, **66**, no. 15, 2 pp.) describes as new *Asio noctipetens*, *Loxia megaplaga*, and *Brachyspiza antillarum*. These species were collected between 23 September and 7 October, 1916 near Constanza, a section of Santo Domingo not previously represented in collections. The second paper by Mr. F. M. Chapman is entitled Descriptions of new birds from Santo Domingo and remarks on others in the Brewster-Sanford collection (Bull. Amer. mus. nat. hist., 14 May, 1917, **37**, p. 327–334); the new species are *Oreopeleia leucometopius*, *Microsiphonorhis* (gen. nov.) *brewsteri*, and *Microligea montana*. In the third paper (Smithsonian misc. coll., 12 July 1917, **68**, no. 7, 3 pp.) Dr. C. W. Richmond describes as new subspecies, *Nyctibius griseus abbotti* from Port de Pimente, and *Vireo crassirostris tortugae* from Tortuga Island. Finally in a paper entitled Additions to the Haitian avifauna (Proc. Biol. soc. Washington, 27 July 1917, **30**, p. 131–132), Mr. Paul Bartsch describes as new *Porzana flaviventris hendersoni*, recognizes the Haitian Golden Warbler as distinct from the Jamaican form (see p. 422) and also records as new to the island eleven forms, six of which *Ereunetes mauri*, *Totanus melanoleucus*, *T. flavipes*, *Chaetura pelagica*, *Hirundo erythrogastra*, and *Dendroica pensylvanica* are not among those noted during my reconnaissance.

I wish to express my thanks to Dr. C. W. Richmond of the U. S. National Museum and to Mr. W. DeWitt Miller of the American

Museum of Natural History for the loan of a series of specimens of *Buteo borealis;* to Messrs. Arthur Harris and M. E. Beall of Monte Cristi and to Messrs. M. A. Peters and Angel Gomez of Sosúa for many courtesies during my stay in these places and to the hospitable natives along the coast between Sosúa and Cabrera.

Special thanks are also due to Mr. Outram Bangs and Dr. Thomas Barbour for many helpful suggestions and criticisms.

ANNOTATED LIST OF SPECIES.

1. PODILYMBUS PODICEPS ANTILLARUM Bangs.

Seramagullon.

The Pied-billed Grebe is apparently a rather rare form on the Island. It was met with but once,— at Laguna Flaca, several miles south of Cabrera, where two were seen on March 10.

2. COLYMBUS DOMINICUS DOMINICUS Linné.

Seramagullon.

A male, Cabrera, March 11.

Rather uncommon. The specimen taken at Cabrera was associated with two or three others of the same species in a small muddy pool less than forty yards across. Three were seen in a lagoon at El Batey on April 5.

3. PELECANUS OCCIDENTALIS Linné.

Alcatráz.

The Brown Pelican seems to be rather uncommon along the north coast, at least during the winter months. I found it at only two localities, Estero Balsa on Manzanillo Bay, February 10 where two or three were seen, and at Margante, March 13 where a single individual was seen flying a short distance off shore.

4. FREGATA MAGNIFICENS Mathews.

Rabijorcado.

Frigate birds were occasionally seen near the coast sailing far overhead. They were by no means common.

5. IXOBRYCHUS EXILIS (Gmelin).

A few Least Bitterns occurred in reedy swamps near the mouth of the Yaqui River at Monte Cristi on February 20. None were taken here nor was the species observed elsewhere.

6. ARDEA HERODIAS REPENS Bangs and Zappey.

Garza.

The West Indian Great Blue Heron occurs rather sparingly on the north coast. Several were found along the Yaqui River February 6. A few others were seen at widely separated intervals along the shore between Gaspar Hernandez and the Rio San Juan early in March. Although no specimens were secured it is probable that all the Blue Herons occurring in Santo Domingo are referable to this form.

7. EGRETTA THULA THULA (Molina).

Garza blanca.

I found this Heron rather uncommon. It was noted only at Monte Cristi, February 6 and at the mouths of the rivers, Piedra, Ori, and San Juan, March 3–14. In the latter localities the birds were observed in small flocks, arising from the mangroves and flying out over the water.

8. HYDRANASSA TRICOLOR RUFICOLLIS (Gosse).

A Louisiana Heron flying into some mangroves near the mouth of the Rio Piedra on March 13 was the only representative of the species noticed.

9. FLORIDA CAERULEA (Linné).

Rather common all along the north coast in suitable locations. Their favorite habitat is the mangrove swamps bordering the streams, but they are frequently found in moist pastures and small pond-holes. Very few birds in the white plumage were noted.

10. Butorides virescens virescens (Linné).

Martinete.

A male Sosúa.

Accidental visitor. The specimen, taken March 29, agrees perfectly in color and size with representatives from the United States; the sides of the neck being more purplish than in *B. v. maculatus,* while all its measurements are larger than typical *B. v. maculatus.* Wing 177, tail 70.5, exposed culmen 60, tarsus 52, middle toe 44 mm.

While I have referred this specimen to the continental form it is perfectly possible that its larger size may be due to individual variation in *B. v. maculatus.* However there is no particular reason why *B. v. virescens* should not occasionally occur in the other of the Greater Antilles, as it has been taken in Porto Rico (Oberholser, Proc. U. S. N. M., **42**, p. 539).

11. Butorides virescens maculatus (Boddaert).

Martinete.

Eight specimens, both sexes, adults, and immature, Monte Cristi, Sosúa.

The Antillean Green Heron is locally common at favorable localities on the north coast of the island. They were rather numerous along the course of the Yaqui River near Monte Cristi. At Sosúa they frequented ditches and mud-holes, seeming to prefer these locations to the larger bodies of water. A small tree overhanging a sluggish stream contained the remains of two of their characteristic nests from which the young had already left by the last week in March.

12. Nyctocorax nyctocorax naevius (Boddaert).

An adult and an immature seen near the Sosúa River, April 10.

13. Ajaia ajaja (Linné).

Spoonbills occur sparingly near Monte Cristi. Mr. Curt Peters showed me a skull he obtained from the marshes at the mouth of the Yaqui River.

14. Phoenicopterus ruber Linné.

Flamingoes are said to occur in the fall near Monte Cristi. Mr. Curt Peters has the skull of one he had killed there.

15. Namanyx dominicus (Linné).

Patico.

A male, El Batey, April 5.

The bird in question was shot in some reeds at the edge of a lagoon. Although apparently an adult male it is not in full plumage. Additional material will probably show either that the Masked Duck has an eclipse-plumage, or that adult plumage is not attained until comparatively late in life.

16. Circus hudsonius (Linné).

A bird in the plumage of the female was seen on several occasions flying over a large *potrero* at Sosúa. Unfortunately the specimen was not secured. So far as I am aware this is the first record for the Marsh Hawk in Santo Domingo; however as it occurs in Cuba and the Bahamas during the winter months its presence on this island need not be considered surprising.

17. Accipiter striatus striatus Vieillot.

This Hawk is apparently absent along the north coast of the island. One was seen at Bulla at the lower edge of the pine ridge on February 12, but was too shy to obtain. It is not included in Dr. Bryant's list and is given as rare by Cory and Verrill. Cherrie secured three specimens in the mountainous southern part of the island.

18. Buteo borealis jamaicensis (Gmelin).

Guaregao.

An adult male, Choco, March 25.

The Lesser Red-tailed Hawk is not an uncommon resident in the hilly or heavily timbered country near the coast, but is generally shy and difficult to approach, or soars at such a height as to be perfectly safe. Besides Choco, where two others were noted in addition to the one taken, the species was seen at Los Toritos, El Batey, and Sosúa.

The status of *Buteo borealis* from the Greater Antilles has long been in doubt, due to the difficulty of obtaining material. Now, however, with a series of eleven birds from all the islands in the group it is possible to reach some definite conclusions. I can detect absolutely no difference in color in adults from either Cuba, Jamaica, Santo Domingo, or Porto Rico; however, the Cuban birds are very large, while those from the other three islands in the group are small,—Cuban *males* are generally larger than *females* from the other islands. Again, *Buteo b. umbrinus* of Florida is identical in coloration with the Cuban bird, differing only in being slightly larger and with stouter feet and claws. In fact for the present it seems best to regard birds from the Florida peninsula, Cuba, and the Isle of Pines as *B. b. umbrinus.*

For the bird inhabiting Jamaica, Santo Domingo, and Porto Rico Gmelin's name *jamaicensis* must be applied. Gmelin's name is based on Latham's "Cream-colored Buzzard" (Syn. **1**, p. 49, n. 30) of Jamaica. There is little doubt that Latham described a form of *Buteo borealis*, but in a remarkable plumage, probably albinistic.

The Verrills described (Proc. Acad. nat. sci. Philadelphia, **61**) *Buteo tropicalis* from San Lorenzo, Dominican Republic. Although their bird is referred to as an adult male there is no doubt that the description actually applies to an immature Red-tailed Hawk, as the tail is said to be crossed by "from 7 to 9 dark bands." The name *Buteo tropicalis* therefore becomes a synonym of *B. b. jamaicensis.*

The following table of measurements shows the relative size of the birds on the different islands and the Florida peninsula.

Buteo borealis umbrinus.

Locality	Museum M. C. Z	Sex	Wing mm.	Tail mm.	Culmen mm.	Tarsus mm.
Florida	E. A. & O. Bangs 3314	♀ ad.	416	287	30.0	89
"	J. E. Thayer 17876	♀ ad.	430	240	32.0	94
Cuba	A. M. N. H. 57400	♂ ad.	376	238	28.0	87
"	U. S. N. M. 23549	♂ imm.	391	225	29.5	85
"	U. S. N. M. 39105	♂ imm.	392	250	29.0	89
Isle of Pines[1]	U. S. N. M. 237092	♂ imm.	343	232	25.0	88

[1] Sexed ♀, probably an error.

Buteo borealis jamaicensis.

Locality	Museum	Sex	Wing mm.	Tail mm.	Culmen mm.	Tarsus mm.
Jamaica	U. S. N. M. 26785	♀ ad.	369	220	28.0	82
“	U. S. N. M. 55078	—	337	205	24.5	75
“	U. S. N. M. 34257	—	336	231	22.5	80
Santo Domingo	M. C.Z. 69481	♂ ad.	337	210	26	78
Porto Rico	U. S. N. M. 177202	♀ ad.	373	230	28	78
“ “	A. M. N. H. 138709	♀ imm.	333	225	25.5	81
“ “	A. M. N. H. 138708	♀ ad.	352	219	27.5	77

19. Rupornis ridgwayi Cory.

Guaregao.

Two males, Laguna Flaca, March 8.

Rare. No other representatives of this species came to my notice.

20. Falco columbarius columbarius Linné.

A female, Arroyo Savanna, March 9.

A rather uncommon winter visitant. Besides the specimen taken, another was seen near Monte Cristi, February 19.

21. Falco sparverius dominicensis Gmelin.

Guallaya.

Thirteen specimens, both sexes. Monte Cristi, Sosúa, Choco.

The Haitian Sparrow Hawk is a common resident all along the north coast, although in a way restricted to the more open type of country. They are particularly common about large *potreros* especially when scattered palms or dead Ceiba trees provide suitable perches and nesting sites.

The series shows a considerable variation in plumage which is neither seasonal or sexual. At least three specimens show strong tendencies towards the characters exhibited by the Cuban bird. Two of them (a male and a female) lack the buffy cinnamon band across the breast which is present in normal Santo Domingan specimens. The third (a female) shows decided erythestic tendencies.

22. PANDION HALIAËTUS CAROLINENSIS (Gmelin).

A rather rare winter visitant. One was seen near Monte Christi on February 17.

23. RALLUS LONGIROSTRIS CARIBAEUS Ridgway.

A male. Monte Christi, February 18.

This specimen, taken at the border of an extensive mangrove swamp near Monte Cristi is the first known instance of the occurrence of this rail on the island.

A comparison with a series of birds from Jamaica and Cuba fails to reveal any differences by which the Haitian bird may be separated from *R. l. caribaeus* or the so-called *R. l. cubanus.*

Locality	Sex	Date	Wing	Tail	Ex. culmen	Tarsus.
Monte Cristi	♂	Feb. 18	149	65	61	50

24. GALLINULA CHLOROPUS CACHINNANS Bangs.

Gallereta.

Two females, El Batey, April 5.

The Gallinule is a rather common resident along the reed-grown banks of lagoons and sluggish streams.

On April 5, I found adults with young still in the black down in a large lagoon at El Batey. About sundown on the same day, while riding from El Batey to Cabarete, we passed a flock of a dozen or more adults drawn up on the bank of the Yasica River where they were preening themselves apparently not noticing us as we pulled up our horses to watch them.

25. IONORNIS MARTINICA (Linné).

Two males, Monte Cristi and El Batey.

This species is not very common; only one other was seen besides the two taken. Natives to whom I showed the specimens seemed to be unfamiliar with it.

26. FULICA CARIBAEA Ridgway.

Gallineta.

A male and a female, El Batey, April 5.

Caribbean Coot occurred rather numerously near El Batey in a certain lagoon formed by an old meander of the Yasica River.

Several pairs were breeding there; in addition to a set (probably incomplete) of seven fresh eggs taken, another nest was found upon which the bird was sitting.

During February coot were seen at Monte Cristi, but as no specimens were taken it is impossible to tell whether they belonged to the resident form or whether they were wintering representatives of *Fulica americana*.

27. ARAMUS VOCIFERUS (Latham).

Guareao.

A female, Sosúa.

Uncommon resident. The one killed at Sosúa, March 22, was in thick brush bordering a dry stream-bed; another noted on March 30, was started from tall grass and flew into a near by piece of woods.

The only notes heard were a few "grunts" when the birds were flushed. Possibly they are more common than these two instances would indicate, as they are largely nocturnal in their habits and are so retiring that it is easy to overlook them.

28. STERNA MAXIMA Boddaert.

Royal Terns were seen in the harbor at Puerto Plata, February 25, and at Sosúa at times until April 11. They were not common.

It is included in Dr. Bryant's list as occurring on the Haitian end of the island. It is not mentioned by Cory or Verrill.

29. EREUNETES PUSILLUS (Linné).

A male, Monte Cristi, February 18.

The Semipalmated Sandpiper is probably a not uncommon winter resident at favorable points on the north coast, as it occurs more or less commonly in Cuba, Porto Rico, and other West Indian Islands.

A few were seen at Monte Cristi between the beach and the mangroves and one shot for positive identification.

30. CALIDRIS LEUCOPHEA (Pallas).

Rare migrant. A Sanderling was seen on the open sand-beach a few miles east of Gaspar Hernandez on March 4.

The species is not included in the lists of Bryant, Cory, and Verrill.

31. ACTITIS MACULARIA (Linné).

Common winter resident. The Spotted Sandpiper was found at Monte Cristi, Sosúa, and along the sand-beaches from Cabarete to San Juan. They often occur where the mangroves adjoin the beach and seem equally at home running up and down the sand or hopping from root to root in the swamps. They were still present on April 11, the day of my departure.

32. SQUATAROLA SQUATAROLA CYNOSURAE Thayer & Bangs.

Rather uncommon winter resident. On February 18, a flock of about 20 birds was observed at Monte Cristi on a flat left bare by the clearing off of mangroves. Two others, both in immature plumage were seen on the hard sand-beach some miles west of the mouth of the Rio San Juan on March 4.

33. OXYECHUS VOCIFERUS RUBIDUS Riley.

Six, both sexes, Jaibón, Gaspar Hernandez.

All of these specimens belong to the small resident form of the Antillean Killdeer. The ovaries of a female taken at Jaibón as early as February 14, showed some slight signs of activity. Two pair were killed at Gaspar Hernandez, March 14, that certainly acted as though mated; the sexual organs of both males and females were somewhat enlarged.

Killdeer were fairly common at Monte Cristi during the second and third weeks in February, though none were taken. It is possible that some of these might have been migrants from North America, as Dr. Barbour tells me that *O. v. vociferus* winters commonly in Cuba.

34. CHARADRIUS SEMIPALMATUS (Bonaparte).

A rather uncommon migrant. A small flock was seen near Monte Cristi, February 18, but none of the birds were secured.

35. Pagolla wilsonia rufinucha (Ridgway).

Titire de Playa.

Ten specimens, both sexes, Monte Cristi, Gaspar Hernandez.

The Rufous-naped Plover occurs along the sand-beaches of the north coast wherever the beach is wide enough to allow a belt of dry sand above high-water mark. Birds taken at Gaspar Hernandez on March 14 appeared to be paired.

All the specimens taken are *P. w. rufinucha.* The West Indian resident form may be easily distinguished from true *P. w. wilsonia* by the darker color of the upper parts, constant in both sexes and by the much richer tone to the rufous on the nape and the sides of the head, particularly in the male.

Both races average about the same size as shown in the following table.

P. w. wilsonia.

Five males, S. E. United States, March to May.

Wing	Tail	Culmen	Tarsus
120 mm.	54.5 mm.	21.2 mm.	29.6 mm.

Five females S. E. United States, March to May.

120.5	55	20.8	29.2

P. w. rufinucha.

Six males from the West Indies, February and March.

120.5	53	21.2	30.8

Seven females from the West Indies, February, March, and July.

119.8	53.4	21.4	29.3

As regards the use of the specific name *crassirostris* Spix for the Rufous-naped Plover, Hellmayr has shown (Abhandl. K. Bayer. akad. wiss., 1906, **22**, p. 715) definitely that Spix's type was undoubtedly a wanderer from North America and that the name *Charadrius crassirostris* Spix (Aves Bras., 1825, **2**) must therefore be cited as a synonym for *Pagolla w. wilsonia* (Ord) Wilson, Amer. Ornith., 1814).

36. ARENARIA INTERPRES MORINELLA (Linné).

Rather uncommon. A few Ruddy Turnstones were seen at Monte Cristi during the second and third weeks in February; two others were observed between Gaspar Hernandez and the Rio San Juan on March 4, in company with a couple of Black-breasted Plover.

37. JACANA SPINOSA VIOLACEA (Cory).[1]

Two males, El Batey.

Uncommon resident. Jacanas were seen in small numbers in the lagoon at El Batey on April 5, but none were observed elsewhere. At Monte Cristi I was shown the wing of one that had been taken in the marshes bordering the mouth of the Yaqui River.

The two birds from El Batey referred to above agree with other West Indian examples except that the color of the abdomen and under tail-coverts is much darker and the greenish black of the breast merges with it, instead of ending abruptly. However, as traces of such a condition appear in a few other birds from Cuba, it is probable that this may be merely a stage through which the bird passes before attaining full adult plumage.

38. OREOPELIA MONTANA (Linné).

A male, Los Toritos.

The Ruddy Quail Dove is fairly common in the dense forests, especially in the northeastern end of the island, but owing to its terrestrial habits, which it shares with other members of the genus, it is easily overlooked.

In some of the other West Indian islands, particularly Cuba, these doves are caught for the market in little traps made of sticks. In Santo Domingo the children indulge in this pastime to a limited extent, but I never found one on sale at any market.

39. OREOPELIA CHRYSIA (Bonaparte).

A male, Arroyo Salado.

Rather uncommon. One killed in rather open woods at Arroyo

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[1] Todd (Annals Carnegie Mus., **10**, p. 217–220) has made out a good case on the status of the Jacanas for Mexico, Central America, and the West Indies; he refers all West Indian birds to the form described by Cory (Bull. Nuttall ornith. club, 1881, p. 129) from Haiti.

Salado, March 7, was the only specimen positively identified. There is a specimen in the M. C. Z. from Puerto Plata taken by Frazar, January 16, 1883.

40. Chaemepelia passerina insularis (Ridgway).

Rolito.

Ten specimens, both sexes, Monte Cristi, Sosúa.

An abundant resident everywhere except in the forests. Ground doves were particularly numerous in the desert of the lower Yaqui Valley where it was not unusual to find flocks of nearly a dozen individuals feeding by the roadside. When disturbed they sometimes made a short flight into the near by cactus brush, but more often took wing for a little distance down the road. They are often absent for over a considerable area in the rain-forest section on the northeast portion of the island.

During late March and early April the males utter a loud *coo* which apparently serves as a song.

Skins of ground doves from Santo Domingo average somewhat smaller than representatives from the Caymans and Cuba; moreover the red at base of the bill is slightly more extensive; however they are precisely like these birds in all other respects and are referable to *C. p. insularis*.[1]

41. Melopelia asiatica asiatica (Linné).

Paloma.

A female, Sosúa.

Uncommon. A few were observed near Sosúa at intervals between February 25 and April 11. No others were seen except a few in the mangrove swamps at the mouth of the Rio San Juan on March 4.

Apparently the White-winged Dove is not numerous anywhere on the Island. Cory (Birds of Haiti and San Domingo, 1885, p. 131) lists his only specimen and the Verrills state that the bird is "Rare, confined to the pine forests of the mountains of the interior."

42. Zenaida zenaida zenaida (Bonaparte).

Tórtola.

Three specimens, both sexes, La Chorrera, Arroyo Savanna.

Zenaida Doves are local in their distribution on the north coast.

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[1] See Bangs, Bull. M. C. Z., **60**, p. 307.

They were common at only one locality, on the Martinez Savanna, southwest of Cabrera, where one or more birds were found in almost every one of the little clumps of woodland which dot the Savanna.

An adult male taken at La Chorrera February 12, so closely approaches *Z. z. lucida* in intensity of coloration that it is almost impossible to separate the two.

The measurements of the series taken are as follows:

M. C. Z.	Locality	Date 1916	Sex	Wing	Tail	Ex. culmen	Tarsus
70045	La Chorrera	Feb. 12	♂	158	96	14	25
70043	Arroyo Savanna	Mar. 9	♂	156	97	14.5	24
70044	" "	" 10	♀	153	91	14	24

43. ZENAIDURA MACROURA MACROURA (Linné).

This West Indian form of the Mourning Dove is decidedly rare on the north coast of the island. The only examples seen were at Monte Cristi where their close proximity to the fort rendered it inadvisable to attempt to collect them.

44. PATAGIOENAS LEUCOCEPHALA (Linné).

Cabeza Blanca.

A few seen at San Juan and Margante, March 12 and 13. According to the natives this species appears on the north coast in August in great flocks, but during the greater part of the year the birds are very local in their distribution and moreover appear to be rather shy.

45. AMAZONA VENTRALIS (Müller).

Cotorra.

Three specimens, both sexes, Arroyo Savanna.

Fairly common in certain localities. None were seen at Monte Cristi although it is said to occur there. The species was most numerous east of the San Juan River and inland from Cabrera. On the big Martinez Savanna from two to a dozen parrots could be started from almost every clump of trees.

At times the birds are cautious, at others almost absurdly tame, sometimes a flock will take flight when approached inside two hundred yards, again they will allow a person to come within fifty feet.

46. CROTOPHAGA ANI Linné.

Judío.

Two males, Sosúa.

The Ani is a very common resident. They are usually found in small compact flocks in pastures and near cattle beside which they hop picking up insects thus started. Their note is a sweet, two-syllabled whistle.

47. SAUROTHERA DOMINICENSIS Lafresnaye.

Pajaro Bobo; Bobo.

Fifteen specimens, both sexes. Monte Christi, Bulla, Sosúa, Choco.

This series shows considerable individual variation both in size and in the color of the throat which is not correlated either with sex or locality. The throat-color varies from a restricted patch of buff on the chin to an extensive area of deep buffy including the chin and upper breast. In some birds the throat-patch is sharply defined, in others it grades off into the gray of the breast, while in one specimen the feathers on the median line of the breast are tipped with buffy.

There is also considerable variation in the length of the bill; however this must also be considered individual as the longest and shortest bills in the series both belong to male birds.

The Lizard Cuckoo receives its native name of Bobo (fool) from its habits. The birds are very tame and permit a very close approach. They rely on their legs to make their way through the brush when pursued, seldom using their wings. A wing-tipped Bobo is almost impossible to catch even on open ground, as they seem to glide (rather than run) with the speed of a snake.

48. COCCYZUS MINOR NESIOTES Cabanis.

Pajaro Bobo; Bobo.

Eighteen specimens, both sexes, Monte Cristi, Sosúa.

Common resident throughout; they are equally at home in the acacia and cactus of the desert about Monte Cristi or the moist situations further eastward.

The amount of individual variation in this series is remarkable. Two specimens are indistinguishable from *C. m. maynardi.* Four others are typical *C. m. nesiotes*, while the rest vary between the two extremes. When arranged in a series Haitian specimens average somewhat lighter below than Jamaican birds and darker than Bahaman representatives; however the range of individual variation is so great as to render it inadvisable to describe a race from Santo Domingo, which at best would be a poorly marked one.

Coccyzus dominicus Bonaparte, (Consp. Avium, 1850, **1**, p. 112), should not be quoted in the synonymy of *C. m. nesiotes* as the figure of *Cuculus dominicensis* (Brisson, Ornith., **4**, pl. 9, fig. 2), upon which Bonaparte's description is based is certainly not that of any form of *Coccyzus minor.* Moreover Brisson includes "Louisianne" in the ange of his Coucou de St. Domingue.

49. SPEOTYTO FLORIDANA DOMINICENSIS Cory.

Cucu; Cucusa.

A pair, Sosúa.

The Haitian Burrowing Owl is somewhat local in its distribution. It was rather common in the desert about Monte Cristi where the holes were found, sometimes in the open, leading in under a cactus, or even the banks of an irrigation ditch. Several birds were started from beside the road between Monte Cristi and Santiago on the night of February 14. When alarmed they flew off uttering a note strongly suggesting the alarm whistle of the Hudsonian Curlew.

The pair taken at Sosúa had a burrow with two entrances dug in red soil which stained both birds on the wings, tail, and top of the head.

In Book XIV, Chap. VII Oviedo says, "There are *mochuelos* [Red Owls] also, small like the *lechuzas* [Barn Owls] or *buhos* [owls], and some even smaller like those of Castilla."

50. TYTO GLAUCOPS (Kaup).

Lechuza.

While I did not actually see the Haitian Barn Owl at any point on the north coast, notes were heard at night at several points which the natives asserted were uttered by the Lechuza. In each case the note consisted of a high pitched nasal "*whāā*." The species is probably not very common.

In Book XIV, Chap. VII, Oviedo relates:

"There are also many lechuzas [Barn Owl] in this island, both in the cities and about the thatch huts, but they are much smaller than the *lechuzas* of Castilla, for they are the size of a *cernicalo* [*Falco tinnunculus*] or even smaller."

51. CHORDEILES VIRGINIANUS GUNDLACHII Lawrence.

In Santo Domingo the West Indian Nighthawk is migratory as it is in the other West Indian islands. As the first representative appeared on the north coast the night before my departure (April 10) I can give no information as to its abundance there.

In speaking of the nocturnal birds on the island of "Española" Oviedo (Book XIV, chap. VII) says — "There are on this island certain birds larger than swifts which have the same wings and manner of flight, and fly with equally great velocity and with the same manner of dipping and rising and turning swiftly about in the air. They do not appear and are not seen until the sun is drawing near to the horizon, also at certain times when the sun does not appear the sky being cloudy. A little before sunset they appear, as also do the bats, and they fly all night. And from time to time they utter a cry which one hears at a great distance . . . . These birds are great enemies of the bats, and they fly striking at them and persecuting them and this is indeed a sight to admire."

52. TODUS SUBULATUS Gray.

Barancolí.

Twenty-two specimens, both sexes. Monte Cristi, Sosúa, Choco, Rio San Juan, Arroyo Salado.

The Haitian Tody is one of the commonest birds found along the north coast. It prefers shady or moist situations where it may be seen sitting in its characteristic attitude, tail pointing almost directly down, bill elevated at an angle of at least forty-five degrees. Suddenly there is flash of green, a whir of wings, a bill snaps once or twice and the Barancolí is again perched motionless.

53. Todus angustirostris Lafresnaye.

Barancolí.

One specimen, Sosúa.

An uncommon species, probably somewhat local in its distribution, although preferring much the same haunts as *T. subulatus.*

In life the bill is dusky above, the lower mandible reddish; iris grey-white; legs dark flesh, feet bluish, soles, yellowish.

54. Streptoceryle alcyon alcyon (Linné).

Fairly common along the coast. The natives assert that the species breeds, but this assertion is as yet unsupported by reliable evidence.

55. Nesoctites micromegas (Sundevall).

El Flotero.

Four specimens, both sexes, Estero Balsa, Sosúa, Los Toritos.

A fairly common resident. Up to within a few days of my departure but three representatives of this species had been observed, all of them taken. For the last two months, however, I had been interested in a song which the natives attributed to El Flotero, but which seemed impossible to locate. The song, most frequently heard in the forests on the northeastern portion of the island, but also occurring rather frequently as the season progressed, in the general vicinity of Sosúa, consisted of a series of six whistled notes which may be written graphically as, ‾ ‾ - _ _ /, the last note rising abruptly and ending sharply.

On April 9, however, I heard the song again and finally located the author, after watching to be sure that I had the right bird I shot it. Rather to my surprise it proved to be a female of this species.

56. Centurus striatus (Müller).

Carpintero.

Nineteen specimens, both sexes, Monte Cristi, Sosúa. Abundant resident. In the desert region of the lower Yaqui Valley it frequents the cactus brush where it forms nest-cavities in the post cactus. Further eastward, in the humid portion of the island these woodpeckers confine their attention almost entirely to the palmettos and royal palms. It is not unusual to see fully half a dozen holes in a single tree. They are often found together in some numbers; on one occasion I counted over twenty-five birds in a single azama tree scattered over the trunk and branches.

Oviedo gives a very accurate description of the Haitian Woodpecker, together with the following account of their nesting habits. . . . "These birds make a deep hole with their bill in palms and other trees, which they work out from the inside and hew to a convenient size, and here they have their nest. . . ."

57. TEMNOTROGON ROSEIGASTER (Vieillot).

This Trogon is rare along the north coast although according to Cory (Birds of Haiti and San Domingo, p. 95–96) it is locally common in certain stations, notably La Vega. The only bird seen during my stay on the island was near Choco on March 25. The specimen, after being shot, managed to escape and was not recovered. A Cuban at Choco to whom I mentioned the occurrence told me that in fifteen years of residence in the Dominican Republic he had met with this species but twice.

58. STREPTOPROCNE ZONARIS MELANOTIS Peters.

Proc. New Engl. zool. club, 1916, **6**, p. 37.

Golandrina.

Four, both sexes, Sosúa.

The Black-collared Swift is not uncommon although the altitude at which it flies, together with its almost bullet-like velocity when on the wing makes it rather difficult to secure. Its occurrence at Sosúa (where I saw it most frequently) was irregular; sometimes none were noted for a week at a time. It was usually seen just before sundown when a flock would appear from the northward, the individuals widely scattered but all approaching gradually in wide sweeping circles, the birds slowly drifting over and passing southward, still feeding as they went.

The species was also noted at Monte Cristi, Choco, and Rio San Juan.

59. TACHORNIS PHOENICOBIA PHOENICOBIA Gosse.

Golandrina.

Three specimens, both sexes, Sosúa.

The Palm Swift is a fairly common resident throughout the region covered, somewhat less numerous in the northeastern part. It usually frequents the tree palmettos where it spends some time even during the day in hiding among the dead lower fronds. It is probable that later in the season the same spots serve as nesting sites.

The note is a Swift-like twittering.

60. MELLISUGA CATHARINÆ (Sallé).

Zumbador.

Three males, Monte Cristi.

While this tiny hummer is fairly common it is rather difficult to collect. Except at Monte Cristi where I found them several times feeding on the flowers of a small herbaceous plant, they choose the dead topmost branch of the largest trees for a perch where they sit motionless and "sing." The "song" consists of a series of rasping "*cheeps*" uttered in quick succession; it is a rather difficult sound to locate as it appears to come from a much larger bird nearer the ground.

61. ANTHRACORAX DOMINICUS (Linné).

Zumbador.

Twenty specimens, both sexes, Monte Cristi, Sosúa, Choco.

Oviedo mentions (Book XIV, Chap. VI) " . . . .some little birds as black as velvet and very fine, and they are so small that I have never seen any of them in the Lesser Antilles, except that one which they call here the 'mosquito bird' which is so small that the bulk of it is less than the terminal joint of the thumb on one's hand."

62. TYRANNUS DOMINICENSIS DOMINICENSIS (Gmelin).

Pitirre.

Nine specimens, both sexes, Monte Cristi, Sosúa.

A fairly common resident at all localities visited, particularly near the coast.

At two points "roosts" were found. Some time before sundown these Kingbirds begin gathering at a particular tree, where they perch in the upper branches, keeping up a continuous calling; fresh arrivals are the signal for a particularly vociferus outburst and sometimes the entire flock rises into the air. This continues until shortly after sundown, the noise and commotion gradually subsiding. The following morning the birds, like most flycatchers, are astir early and soon scatter quietly to their respective stations for the day.

63. Tolmarchus gabbi (Lawrence).

Four males, Monte Cristi, Bulla.

Gabb's Petchary was not uncommon in the cactus brush about Monte Cristi; a few were also seen at Bulla at the edge of the pine ridge but none were observed elsewhere.

64. Myarchus dominicensis (Bryant).

Maroa; Maroita.

Eleven specimens, both sexes, Monte Cristi, Sosúa, Choco. Fairly common.

65. Blacicus hispaniolensis (Bryant).

Sigua.

Three males, Monte Cristi, Gaspar Hernandez, Rio San Juan. The Haitian Wood Pewee is decidedly uncommon. In addition to the three specimens listed, only one other was seen,— at Estero Balsa. All except a bird killed at Monte Cristi February 10 were found in mangroves.

Cherrie states (Publ. Field Columbian Mus. Ornith. series, **1**, p. 17) that the species is "far more common" at the higher altitudes.

66. Mimus polyglottos orpheus (Linné).

Ruiseñor.

Twelve specimens, both sexes, Monte Cristi, Sosúa, Choco.

I found the Mockingbird to be an extremely common resident at all points visited. They were somewhat less numerous in the northeast portion of the island, due probably to the absence of large open tracts. Males were in full song throughout my stay on the island.

A comparison of the above series with birds from Jamaica shows no constant difference whereby the Jamaican bird (*M. p. orpheus*) may be distinguished from the so-called *M. p. dominicus* which has heretofore been considered the resident bird of Haiti. The subspecific character of *M. p. dominicus* is supposed to consist in the more extensive white at the base of the primaries, the amount, however, varies to such an extent in the forms under discussion that its value as a diagnostic mark is useless. It seems best therefore to consider the Mockingbirds from Haiti as being identical with those of the other Greater Antilles. As *Mimus polyglottos orpheus* (Linné, Syst. nat., ed. 10, 1758, **1**, 169) antedates *M. p. dominicus* (Linné, Syst. nat., ed. 12, 1766, **1**, 295) the name of the Haitian Mockingbird becomes *Mimus polyglottos orpheus* (Linné).

67. MIMOCICHLA ARDOSIACEA ARDOSIACEA (Vieillot).

Two specimens, Sosúa, Choco.

This Thrush is rather uncommon along the north coast. In addition to the localities noted above a few were seen at Monte Cristi. At Bulla, 1200 feet, at the beginning of the pine ridge the birds were somewhat more abundant. Everywhere they were very shy and retiring, never venturing far from suitable cover.

68. CORVUS LEUCOGNAPHALUS ERYTHROPHTHALMUS Württemburg.

Cuervo.

A female, Rio San Juan.

Along the north coast this Crow is very local in its distribution. Several were seen in the cactus woods near Monte Cristi. They also occurred at the mouth of the Rio San Juan in some rather extensive mangrove swamps, but none were found except at the two localities mentioned.

69. LAWRENCIA NANA (Lawrence).

A male, Sosúa.

The bird in question, the second known record, was taken at the edge of a piece of woodland on April 8. It had just flown across a little open stretch and alighted in a small tree through which it was searching in a most Vireo-like manner when I shot it.

Through the courtesy of Mr. H. C. Oberholser I had the privilege of examining the type of this species. It is evident that it has faded considerably since its capture over forty years ago, as the upper parts have a decidedly brownish tinge, whereas in the fresh specimen they are greener.

70. VIREOSYLVA CALIDRIS CALIDRIS (Linné).

Eight males, Monte Cristi, Sosúa.

As elsewhere in the Greater Antilles, this Vireo appears to be migratory. I shot my first one, at Monte Cristi on February 8. No others were taken there, and on the whole the species seemed to be uncommon. At Sosúa and eastward the Vireos were common when I arrived and up to the time of my departure their songs formed the bulk of the bird notes to be heard in the heavy timber.

Wetmore (Birds of Porto Rico, p. 97) states that no females were taken by him in Porto Rico until April 11. In my series, the last bird shot on April 4, there are no females, although I feel reasonably certain that they had arrived at least by the first of the month.

The song of the Jamaican Vireo is very similar to that of the Red-eyed Vireo, but slightly richer in tone.

The upper mandible is dark brown; lower mandible bluish brown; iris dark red-brown; legs and feet bluish.

71. DULUS DOMINICUS (Linné).

Sigua prieta.

Twenty-three specimens, both sexes, Monte Criste, Bulla, Sosúa;

The Palm Chat was not particularly common at Monte Cristi, but at the other localities visited, it was abundant, easily the commonest species on the island.

They are very gregarious, feeding in flocks and breeding in colonies; all the females in the colony occupy an enormous communal nest, which is invariably placed in a palm tree. The presence of either a nesting colony or a flock feeding is realized at once by their harsh rasping notes, suggestive of those of the Starling. When feeding they are very tame, and even after one or more of their number has been killed the birds will return almost at once to the same tree to continue feeding.

The series exhibits a considerable variation both in size and color;

in the males the wing measurements range from 83 mm. to 94 mm. In the female the range is from 85 mm. to 91 mm. The streaking on the under parts varies greatly in amount. In some specimens the throat and upper breast are almost entirely dusky, while in others the light and dusky are about equal in amount.

Oviedo devotes (Book XIV, Chap. V) considerable space to an account of the "communal birds" "now there is in this island a kind of bird somewhat smaller than those which in Castilla are called gorriones [sparrows] or pardales [linnets] and they are similar somewhat in plumage and diligence and are not less astute or malicious. They are greatly minded to stay in large flocks. The color of their plumage is dusky gray, and they build a nest as large or larger than those which the storks are accustomed to make in the belfries and towers of Castilla. They build upon a branch in a manner so complicated and mixed up with twigs as to raise great admiration because the birds are so small. Inside of this nest they have their different apartments or cells where each pair breed, and at the least a nest may hold two to three hundred birds. And if a large bird should happen by, especially a predacious one like a guaraguaos (which they say here eat chickens) the little birds sally forth in squadrons with a great noise and strike violently at the enemy. There are no bees or any other thing of such energy and persistence. Finally they rout it, when they follow it making swift thrusts and dragging out feathers."

72. PETROCHELIDON FULVA FULVA (Vieillot).

Golandrina.

Five specimens, both sexes, Monte Cristi, Rio San Juan.

The Haitian Cliff Swallow are somewhat local in their distribution. During February they were common along the Yaqui River and abundant over the *salinas* and mud-flats between the town of Monte Cristi and the landing.

They were common at the mouth of the Rio San Juan on March 4, and a few were also noted at Sosúa.

73. PROGNE DOMINICENSIS (Gmelin).

Golandrina.

Two males, Sosúa, Rio San Juan.

The Caribbean Martin appeared rather uncommonly at the localities visited, although widely distributed. One was seen with Cliff Swallows at Monte Cristi, February 22. A few noted about the fort at Puerto Plata, February 26. They also occurred at Sosúa, Rio San Juan, and Abreo.

Oviedo (Book XIV, Chap. II) says of the Caribbean Martin " .... the song of the swallows of these parts is fainter and not like that of our Spanish bird, nor do they breed so familiarly about the houses here, possibly because as yet there are few houses of stone in the island. For in very truth they have already commenced to nest in the cathedral of this city [Santo Domingo] and in the monastery of the Dominican friars in this city."

74. SETOPHAGA RUTICILLA (Linné).

Three specimens, both sexes, Sosúa, Rio San Juan.

Although most collectors have found Redstarts to be common on the island, on the north coast they are quite the reverse. I failed to find one until March 5, when I shot an adult male at the Rio San Juan. They were uncommon at Sosúa from March 15 onwards; the last one seen was a female killed there on April 4.

75. GEOTHLYPIS TRICHAS BRACHIDACTYLA (Swainson).

Five specimens, both sexes, Sosúa.

During the winter Northern Yellow-throats are not found very commonly anywhere along the north coast of the Dominican Republic. They were uncommon at Monte Cristi from February 5 to 23; seen only once (March 2, a female taken) between February 25 and March 3 at Sosúa, not noted at all while travelling through the northeastern portion of the island March 3 to 14, but becoming commoner at Sosúa after March 15 and very common after April 1. The last specimen was taken April 8, though there was no sign of diminution in numbers on April 10, the day before my departure.

All five specimens appear to be typical *C. t. brachidactyla.*

76. SEIURUS NOVEBORACENSIS NOTABILIS (Ridgway).

A female, Monte Cristi.

Water-thrushes were rather uncommon. They were generally confined to the mangrove swamps where they are extremely difficult to secure. The only specimen taken was shot in some thick growth at the edge of the beach. A larger series would undoubtedly show a predominance of *S. n. noveboracensis*, as *S. n. notabilis* is probably rare.

77. Seiurus aurocapillus (Linné).

Seven specimens, both sexes, Sosúa, Arroyo Salado.

The case of the Oven-bird closely parallels that of the Northern Yellow-throat. None were noted at Monte Cristi, though one was seen near Mao on February 12. It was not common at Sosúa, February 25 to March 3, but became somewhat more numerous northeastward March 3 to 14. After March 15, it was common at Sosúa and Choco, increasing in numbers toward the end of the month, and showing no sign of diminution as late as April 10.

78. Dendroica palmarum palmarum (Gmelin).

One, sex not determined, Bulla.

A few were noted at most every locality visited prior to March 15. After that date the species was uncommon. A particularly bright plumaged bird was seen at Sosúa, April 10, but was not secured.

79. Dendroica discolor (Vieillot).

Five specimens, both sexes, Monte Cristi, Sosúa, Rio San Juan.

Rather uncommon winter resident near the coast, but a fairly common migrant from the middle of March onward. Several were heard singing, though not vigorously or persistently, toward the end of March and into April.

80. Dendroica dominica dominica (Linné).

Two specimens, a pair, Bulla.

Met with only at Bulla, where two birds were taken on February 12.

81. Dendroica coronata (Linné).

Two females, Monte Cristi, Sosúa.

An abundant winter resident, particularly common at Monte Cristi, where they appeared equally at home in the cactus woods or the acaciao. They depart rather earlier than most of the North American migrants, being much reduced in numbers by March 15 and practically all have left by April 1. A straggler was killed at Sosúa, April 10. the bird was a female in worn plumage and showed no signs of sexual activity.

82. Dendroica caerulescens caerulescens (Gmelin).

Three specimens, both sexes, Choco, Los Toritos.

The Black-throated Blue Warbler is a common migrant on the north coast, but does not occur to any extent during the winter. The first individuals were seen on March 11, and by the 25th the species had reached its greatest abundance. None were seen after April 1.

83. Dendroica tigrina (Gmelin).

Five specimens, both sexes, Monte Cristi, Jaibón, Sosúa, Arroyo Savanna.

Common winter resident.

82. Dendroica petechia albicollis (Gmelin).

Three specimens, Monte Cristi.

Brisson in his Ornithologie describes and figures (**3**, p. 494, pl. 26, fig. 5) Le Figuier de S. Domingue, *Ficedula dominicensis*. His description is most certainly that of *Dendroica petechia*, probably a young male, as the throat and breast are described as being a soiled yellowish white. The chances that any other Dendroica except possibly *D. aestiva* could be included in Brisson's account may be rejected, as the inner webs of the lateral retrices are mentioned as being extensively yellow. His measurements agree with those of *D. p. petechia* quite well, moreover there is no certain record for *D. aestiva* in the West Indies. His female is similar to the male except that there is a little ashy on the upper part of the neck.

In the same work (**3**, p. 496, pl. 26, fig. 2) he describes Le petit Figuier de S. Domingue, *Ficedula dominicensis minor*. This time his account refers to a female of *D. petechia* as reference to the streaking on the breast is omitted; the under parts are again a dirty yellowish white, but the inner webs of the lateral retrices are more extensively yellow. The "female" differs in that the colors are less bright and the belly less yellow.

In both cases the habitat is "S. Domingue," "when specimens have been sent to M. de Reamur by M. Chervain" Gmelin (Syst. nat. 1788, **1**, pt. 2, p. 983) bases the name of [*Motacilla*] *albicollis* on Le Figuier de S. Domingue and that of [*Motacilla*] *chloroleuca* (p. 984) on Le Petit Figiuer de S. Domingue, both of Brisson.

As the Golden Warbler of Haiti is a well-marked race and as there is no doubt that the birds of Brisson upon which Gmelin based his names *M. albicollis* and *M. chloroleuca* were a race of *Dendroica petechia*, Gmelin's name *albicollis* stands for the Haitian bird by reason of priority of pagination with *chloroleuca* as a synonym.

The only peculiar point in Brisson's descriptions is that he did not have any fully plumaged birds, all of them possessing "soiled yellowish white" throats and breasts.

Dendroica petechia albicollis is closest to *D. p. petechia* of Jamaica: it differs from *D. p. gundlachi* of Cuba in being much lighter. The bill is shorter and more slender than any of the *Dendroica petechia* group, and this character alone serves to separate it from either *D. p. flaviceps* of the Bahamas or *D. p. cruciana* of Porto Rico.

Subspecific characters.— Similar to *Dendroica petechia petechia* (Linné) but much smaller (approaching *D. p. gundlachi*). Upper parts, sides of head, and edging of primaries, secondaries, and wing-coverts lighter, more golden, less olive-yellow; forehead and crown more orange, less ochreous; traces present in juv. ♂ and ad. ♀. Dusky portions of remiges and rectrices less dark, more brownish (Ridgway, Bull. 50, U. S. N. M., **2**, p. 515). Yellow of under parts more intense, streaks fewer, averaging less heavy. Bill short, very slender.

Measurements.

Locality	M. C. Z.	Sex	Wing	Tail	Ex. culmen	Tarsus
Monte Cristi	70183	ad. ♂	62.2	54	10.3	21
" "	70184	♂	62	52	10.3	20.4
" "	70185	♀	61	53	10.4	20.8

The Monte Cristi Golden Warbler was observed only near Monte Cristi. The three birds taken were the only ones seen. It is not recorded by either Bryant, Cory, Cherrie, or even Verrill. Ridgway refers to an adult male from Haiti (Bull. 50, U. S. N. M., **2**, p. 515), but the collector's name is not given.

Doubtless the types collected in "S. Domingue" by Chervain and sent to de Reamur have long since disappeared. They were probably taken in the western or Haitian portion of the island which at that time was a French colony.

83. COMPSOTHLYPIS AMERICANA USNEÆ Brewster.

Although Parula Warblers are said to be common, by most collectors, I saw this bird but once, one shot near Monte Cristi on February 10; unfortunately the specimen was not preserved.

84. MNIOTILTA VARIA (Linné).

One female, Rio San Juan.

Rather uncommon migrant along the north coast. It was seen in small numbers, mainly about Sosúa.

85. COEREBA BANANIVORA (Gmelin).

Siguita.

Eight specimens, both sexes, Monte Cristi, Sosúa.

At Monte Cristi bananaquits were found almost exclusively on the flowers of the Agave. At Sosúa and eastward, where this plant is absent their favorite habitat was the upper branches of the tall trees comprising the forests, only on one occasion was the bird seen in the proximity of bananas.

The breeding season appears to extend over a considerable portion of the year. Birds not over two months old were killed at Monte Cristi between February 7 and 21; an adult female showing a well-worn incubation patch was taken at Sosúa, March 30.

These birds are very unsuspicious and permit a very close approach.

86. ICTERUS DOMINICENSIS (Linné).

Calandra.

Sixteen specimens, both sexes, Monte Cristi, Sosúa, Arroyo Salado.

Of the series collected there are seven adult males and three adult females in full plumage. One of the remaining six birds is a male, the others are females, all fully grown but in immature plumage.

Transition from the first to the adult plumage is seen in the gradually blackening of the primaries, secondaries, and rectrices from the central shaft outwards; black feathers appear scattered on the pileum, scapulars, back, and throughout the under parts. The feathers on the rump, lesser wing-coverts, upper and under tail-coverts become clearer yellow, less olive-yellow. In all plumages the bill is black, legs and feet bluish, iris hazel.

This Calandra is a rather common resident. At Monte Cristi I found it in some numbers about the Agaves which were then in blossom. At these times they seem to associate freely with bananaquits, hummingbirds, and woodpeckers.

87. HOLOQUISCALUS NIGER (Boddaert).

Chinchilin.

Seventeen specimens, both sexes, Sosúa.

The Chinchilin is a common resident though somewhat local in its distribution. It is never found very far from water. In the Monte Cristi region it is confined exclusively to the marshes along the Yaqui River. As a rule, however, almost any mud-hole, particularly if surrounded by thick brush is sure to harbor a few of these birds. Flocks often resort to cleared lands to feed.

88. PHOENICOPHILUS PALMARUM (Linné).

Cuatro ojo; Sigua.

Twenty-three specimens, both sexes, Monte Cristi, Bulla, Sosúa, Choco, Rio San Juan.

The Palm Tanager is an abundant resident at all points along the north coast and inland. They appear to be equally at home in all locations, but generally show a preference for brush or undergrowth. They are extremely silent birds, the only note I ever heard them utter was a *chip*, much like the call-note of a Chipping Sparrow.

In life the upper mandible is black, the lower blue-gray tipped with black; iris hazel; legs and feet bluish.

The native name "Cuatro ojo," four eyes, is suggested by a large white spot on either side of the forehead which gives the bird the appearance of having a supernumerary pair of eyes.

89. Spindalis multicolor (Vieillot).

On February 12 I shot a Spindalis near Bulla, but being only wounded the bird escaped. Judging from the accounts of other collectors this species is extremely local in its distribution and is probably confined to the interior of the island, though Cory (Birds of Haiti and San Domingo, p. 55) lists a specimen from Puerto Plata, a male, taken December 2, 1882.

90. Pyrrhulagra violacea affinis (Baird).

Calandra.

Ten specimens, both sexes and young, Monte Cristi, Sosúa, Arroyo Salado.

The Haitian Bullfinch is a rather uncommon species although it is pretty evenly distributed throughout the region traversed. It is distinctly a bird of the undergrowth, especially in moist hollows or near streams. The only note I ever heard it give was a faint thin "chip."

Two specimens taken at Monte Cristi on February 9, are young birds probably hatched in December.

91. Tiaris olivacea olivacea (Linné).

Siguita.

Twenty specimens, both sexes, Monte Cristi, Santiago, Sosúa, Choco.

A common species in the cane-fields and pastures about Sosúa, less numerous at Monte Cristi.

Males show a wide range in the development of the black patch on the breast. This appears to be largely seasonal. A bird taken near Santiago, February 14, has the black restricted to a small area on the lower throat, while on others from Sosúa and Choco taken late in March and early in April it covers the entire breast.

The song of the Yellow-faced Grassquit is a short insect-like trill, slightly ventriloquial. It is always given from a somewhat exposed perch, a tall stalk of cane, a fence-post, or a bush in a pasture. The call-note is a sparrow-like chip.

92. AMMODRAMUS SAVANNARUM INTRICATUS Hartert.

Nine specimens, both sexes, Arroyo Savanna.

This species was found only on a large savanna, twenty-five miles southwestward of Cabrera; here they were not uncommon.

The Santo Domingan race was described by Hartert (Bull. B. O. C., **19**) from specimens taken by A. H. Verrill at El Valle, S. D., January 16, 1907. All the differences pointed out by Hartert appear to hold good in my series, in fact the difference in color between it and *A. s. savannarum* is so striking when viewed in a series that the bird might almost be raised to full specific rank.

In notes and habits the El Valle Grasshopper Sparrow resembles the North American bird. Breeding probably commences late in March. In specimens taken at Arroyo Savanna, March 8 to 10 the sexual organs show signs of activity, moreover the males were constantly singing.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXI. No. 12.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE TROPICAL PACIFIC IN CHARGE OF ALEXANDER AGASSIZ, ON THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM AUGUST, 1899, TO MARCH, 1900, COMMANDER JEFFERSON F. MOSER, U. S. N., COMMANDING.

XVIII.

REPORTS ON THE SCIENTIFIC RESULTS OF THE EXPEDITION TO THE EASTERN TROPICAL PACIFIC IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," FROM OCTOBER, 1904, TO MARCH, 1905, LIEUT. COMMANDER L. M. GARRETT, U. S. N., COMMANDING.

XXX.

OPHIUROIDEA.

By Hubert Lyman Clark.

With Five Plates.

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No. 12.— *Reports on the scientific results of the Expedition to the Tropical Pacific in charge of Alexander Agassiz, on the U. S. Fish Commission Steamer Albatross, from August, 1899, to March, 1900, Commander Jefferson F. Moser, U. S. N., Commanding.*

XVIII.

Reports on the scientific results of the Expedition to the Eastern Tropical Pacific in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer Albatross from October, 1904, to March, 1905, Lieut. Commander L. M. Garrett, U. S. N., Commanding.

XXX.

Ophiuroidea.

By Hubert Lyman Clark.

The number of ophiurans collected by the Albatross on her Tropical Pacific expeditions was not large and it has seemed best to make a single report on the two collections. They were originally sent to Professor Ludwig at Bonn, but he had made only a preliminary examination when his untimely death cut short his researches. There are in all about 550 specimens, representing 50 species. Of these 168 specimens of 20 species were taken during the cruise of 1899–1900, and 381 specimens of 33 species were collected in 1904–05. There are also included a very few specimens taken by the Albatross in 1891, which have never yet been placed on record. Only 7 species are new to science and one third of the remainder are common shallow-water species of Pacific reefs and shores.

OPHIOMYXIDAE.

OPHIOGERON EDENTULUS.

Lyman, 1878. Bull. M. C. Z., **5**, p. 161. 1882. Challenger Oph., pl. 12, fig. 16–18.

A single specimen, with the disk-covering torn away, measures 5 mm. across the disk and has arms 18–20 mm. long. It is somewhat larger therefore than the Challenger specimens from near the Fiji Islands. The species has not previously been collected since the Challenger report was issued.

Station 4732. A thousand miles east of the Paumotu Islands, Eastern Tropical Pacific, 2012 fms. Bott. temp. 34.8°. Glob. oz.

Trichasteridae.

Asteroschema monobactrum,[1] sp. nov.

Plate 1, fig. 1, 2.

Disk, 8 mm. in diameter; arms 80–90 mm. long; width of arm at base, about 2 mm.; height of arm at base, about 1.8 mm. Disk flattened, slightly higher than arms, concave at center (in dry specimen), covered by a granular membrane; near center of disk there are about 50 granules to a square millimeter, while near margin there are not more than 30. Radial shields almost completely concealed, but in the dry specimen appear as low, rounded ridges, about 3 or 4 times as long as the wider, outer end. Arms rather squarish (in cross-section) at base and wider than high, but becoming more arched dorsally and apparently higher than wide; they are covered by a granulated skin like that of disk but near tip, the granules are more and more separated until the skin is almost naked and the granules very minute. Genital slits very conspicuous, the two together occupying nearly all the interbrachial space; each is 2 mm. long and .60–.75 mm. wide; the narrow vertical area or ridge separating them is sunk conspicuously below the rest of the interbrachial area. Oral shields, adoral plates, and oral plates completely concealed beneath granulated skin of disk. Oral papillae (if they can be called such) not more than two on a side, nearer tip of jaw than base, small, rounded and knob like, irregular in form, size, and position. Tooth papillae none. Teeth 4 or 5, rounded triangular. Under arm-plates (if present) at base of arm, concealed by granulated skin; at middle of arm and beyond where skin is thin and nearly or quite naked, there seem to be no under arm-plates. Tentacle-pores small but distinct; diameter equal to about one eighth of distance between first and second pairs of pores on arm. Buccal pair and first arm-pair with no

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[1] μόνος = single + βάκτρον = club, in reference to the single tentacle-scale on basal pores of arm.

tentacle-scales; second arm-pair, and following 10–15 pairs have a single, cylindrical tentacle-scale; distally this scale is more and more thickened and rough or even prickly at tip. Beyond basal part of arm, each tentacle-pore is guarded by two scales, of which the outer is much the smaller, scarcely half the size of the inner, which may be over a millimeter long, considerably exceeding the arm-segment. Color of dry specimen, dull cream-color.

Station 3685. Off the Marquesas Islands, Eastern Tropical Pacific, 830 fms. Bott. temp. 38°. Vol. s., glob.

One specimen.

This species is very different from *A. sublaeve* of the Galapagos Islands and Panamic region, its nearest ally geographically. Nor does it resemble any more closely the related forms of the western Pacific. On the contrary it is really nearer to *A. arenosum* of the West Indies than to any other species, so far as general appearance and granulation of disk and arms is concerned. The size and arrangement of the genital slits and the absence of a second tentacle-scale on the basal arm-segments serve as excellent marks of distinction.

OPHIACANTHIDAE.

OPHIACANTHA CONTIGUA.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 173, pl. 17, fig. 7–9.

Six specimens, ranging in size from 4 to 6.5 mm. across the disk agree very closely with the original description and figures of *O. contigua*. There are, however, more oral papillae, 4 or even 5 being present on each side of each jaw.

Station 4621. Panama: off Mariato Point. 581 fms. Bott. temp. 40.5°. Gn.s., gn. m., r.

OPHIACANTHA COSMICA.

Lyman, 1878. Bull. M. C. Z., **5**, p. 146. 1882. Challenger Oph., pl. 13, fig. 13–15.

In addition to some excellent specimens, with disks ranging from 10 to 15 mm. across, there are some specimens from an unknown station which are in wretched condition.

Station 4651. 111 miles northwest of Aguja Point, Peru. 2222 fms. Bott. temp. 35.4°. Fne. stk. gy. m.

Station 4674. 86 miles southwest of Palominos Light House, Peru. 2338 fms. Fne. dk. gn. m., r.

Eleven specimens.

OPHIACANTHA QUADRISPINA,[1] sp. nov.

Plate **1**, fig. 3, 4; Plate **2**, fig. 3.

Disk, 18 mm. in diameter; arms about 100 mm. long. Disk covered by a coat of fine scales which is more or less completely concealed beneath a covering of coarse granules, 25–35 per square millimeter. About one square millimeter or a little more of the distal end of each radial shield is bare. Upper arm-plates wider than long, separated or barely in contact, diamond-shape but with distal angle much more obtuse than proximal; near tip of arm, they are nearly triangular and about as long as wide. On the interbrachial areas below, the granulation occupies only the central, marginal portion, the region bordering the genital slits and distal to the oral shield being quite bare, though covered with very fine scales. Genital slits of unequal lengths, sometimes equal to only the two basal arm-segments and sometimes equal to four. Oral shields distinctly wider than long; the madreporite is pentagonal with slightly concave sides, and is widest proximally; the other shields are diamond-shaped with rounded angles, slightly concave sides and a conspicuous distal projection into the interradial area. Adoral plates nearly or quite straight with almost parallel sides, about 3 times as long as wide, meeting broadly in the interradii but separated radially by the first under arm-plate; often, but by no means always, a distal projection of the adoral plate separates the oral shield from the first under arm-plate; in the 40 possible cases, this projection is present 25 times. Oral plates superficially about as large as adorals; on the margin of each are 3–6 papillae of very variable size and arrangement; as a rule the distalmost is largest and the middle ones smallest, but the distal ones may be quite lacking. Teeth five in each column; below (or external to) lowest, is a group of 2–4 tooth-papillae, each about equal to half a tooth. First under arm-plate, small, squarish, a little

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[1] *Quadrispinus* = having four spines; in reference to the small number of arm-spines.

wider than long; succeeding plates wider than long (until past middle of arm) pentagonal or somewhat heptagonal, with a proximal angle and slightly concave sides; they are separated throughout. Side arm-plates large, low and wide, meeting both above and below; each carries 4 blunt spines, of which the upper three are very flat and wide; the two middle spines are chisel like at tip and in length are equal to two or two and a half arm-segments; none of the spines are prickly but under a lens, the margins are very finely serrate. Tentacle-scales 2, large and flat; they are situated on the side arm-plate but the inner is very close to the under arm-plate; inner scale a trifle the longer and distinctly the narrower, about equal in length to the lateral margin of the under arm-plate; beyond the middle of the arm the inner scale is much the smaller and is attached to the under arm-plate, and still further out it disappears altogether. Color dull purplish brown above, whitish beneath; arms conspicuously banded with these two shades, the bands each 2–6 segments wide, but the whitish bands always the narrower.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

Station 4643. Galapagos Islands: Hood Island, 5 miles southwest of Ripple Point. 100 fms. Bott. temp. 67.2°. Brk. sh., glob.

Four specimens.

This is a very well-marked species, not likely to be confused with any other. While it resembles *O. normani* in having four arm-spines, the shape of those spines is very different; the presence of two tentacle-scales and the absence of granules on the upper arm-plates are additional differences of great importance. The superficial appearance is much like that of some specimens of *O. cataleimmoida*, but that species has six or seven arm-spines and only a single tentacle-scale. In tentacle-scales, under arm-plates, and mouth-parts, *O. quadrispina* is very similar to *O. valenciennesi*, but that species has seven or eight arm-spines and spinules on the upper arm-plates. The constancy in the number of arm-spines in *O. quadrispina* is very striking for there are no more than four on the basal arm-segments and there are not fewer than four on the distal segments until near the tip of the arm. It seems fair then to consider this one of the characteristic endemic brittle-stars of the Galapagos Islands, very few of which are as yet known.

OPHIACANTHA SENTOSA.

Lyman, 1878. Bull. M. C. Z., **5**, p. 140. 1882. Challenger Oph., pl. 13, fig. 10–12.

The Albatross specimens are not quite so large as those taken by the CHALLENGER, but they do not exhibit any noteworthy differences. The depth at which the species lives is notable.

Station 4658. West of Peru, 8° 30′ S., 85° 36′ W., 2370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Station 4666. West of Peru, 11° 55′ S., 84° 20′ W., 2600 fms. Bott. temp. 34.9°. Fne. gy. rad. oz.

Station 4672. Southwest of Palominos Light House, Peru, 88 miles. 2845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Bathymetrical range, 2370–2845 fms. Extremes of temperature, 35.3°–34.9°.

Three specimens.

OPHIACANTHA VALENCIENNESI.

Lyman, 1879. Bull. M. C. Z., **6**, p. 57. 1882. Challenger Ech., pl. 26, fig. 7, 8.

The specimens of this well-marked, nearly cosmopolitan species are notable for the development of the spinules on the upper armplates. They may occur out as far as the twentieth segment or a little beyond and there may be 5 or 6 on the distal margin of each plate. On the basal segments, there are pointed granules, rather than spinules.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

Four specimens.

OPHIOTOMA PAUCISPINA.

Ophiacantha paucispina Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 175, pl. 18, fig. 1–4.

Ophiotoma paucispina H. L. Clark, 1915. Mem. M. C. Z., **25**, p. 218.

The specimens are in poor condition and throw little light on the character of the species or on its relationship to the other members of the genus.

Station 4647. West of Peru, 4° 33′ S., 87° 42′ 30″ W., 2005 fms. Bott. temp. 35°4. Lt. gy. and br. glob. oz.

Two specimens.

Amphilepididae.

Amphiactis duplicata.

Amphiura duplicata Lyman, 1875. Illus. cat. M. C. Z., no. 8, pt. 2, p. 19, fig. 87; pl. 5, fig. 78.

Ophiactis duplicata Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 142.

Amphiactis duplicata Matsumoto, 1915. Proc. Acad. nat. sci. Philadelphia, **67**, p. 67.

This series is not noteworthy. The range in size is from 3.5 to 5.5 mm. across the disk.

Station 3407. Galapagos Islands: 4′ S., 90° 24′ 30″ W., 885 fms. Bott. temp. 37.2°. Glob. oz.

Station 4641. Galapagos Islands: Hood Island, 12 miles southeast of Ripple Point. 633 fms. Bott. temp. 39.5. Lt. gy. glob. oz.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

Bathymetrical range, 300–885 fms. Extremes of temperature, 48.6°–37.2°.

Twelve specimens.

Amphilepis patens.

Lyman, 1879. Bull. M. C. Z., **6**, p. 34. 1882. Challenger Oph., pl. 19, fig. 1–3.

Amphilepis platytata H. L. Clark, 1911. Bull. 75 U. S. N. M., p. 171, fig. 76.

This series shows that the differences which were supposed to distinguish *A. platytata* from *A. patens* (absence of tentacle-scales and of disk-scaling on the lower surface) are probably growth-stages, or at any rate a matter of individual diversity. In two specimens, with disk-diameter 6.5–8 mm., there are no tentacle-scales and the interbrachial areas below are perfectly naked; they are thus like the type of *A. platytata* which was 8 mm. across the disk. The other specimens are 10–12.5 mm. across the disk and the interbrachial areas below are fully covered with scales.

There is no doubt of the identity of the specimen labeled 3389, but it is possible that there is some mistake about the station number, as the original label is not with the specimen. It seems highly improbable that this species occurs in 210 fms. at a temperature of 48.8°.

Tentacle-scales are either present or absent, generally present on the majority of the pores. The oral papillae are exceedingly variable in number, size, form, and position, so that no reliable specific character can be based on them.

Station 3389. Off Panama, 7° 16′ 45″ N., 79° 56′ 30″ W., 210 fms. Bott. temp. 48.8°. Gn. m.

Station 4647. Eastern Tropical Pacific, 4° 33′ S., 87° 42′ 30″ W., 2005 fms. Bott. temp. 35.4°. Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, 5° 17′ S., 85° 20′ W., 2235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4651. 111 miles west of Aguja Point, Peru; 5° 42′ S., 83° W. 2222 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4717. Eastern Tropical Pacific, 5° 11′ S., 98° 56′ W., 2153 fms. Bott. temp. 35.2°. Rd. c., glob. oz.

Bathymetrical range, 210(?)–2235 fms. Extremes of temperature, 48.8°(?)–35.2°.

Ten specimens.

AMPHIURIDAE.

OPHIACTIS SAVIGNYI.

Ophiolepis savignyi Müller and Troschel, 1842. Syst. Ast., p. 95.
Ophiactis savignyi Ljungman, 1867. Öfv. Kongl. vet.-akad. Förh., **23**, p. 323.

The specimens are all young and in no way noteworthy.

Panama: Perico Island.

Ellice Islands: Funafuti.

Gilbert Islands: Taritari.

Thirteen specimens.

AMPHIURA DIOMEDEAE.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 151, pl. 12, fig. 1–7.

The specimens of this wide-ranging Pacific species are in good condition. The disk-diameters are 8–14 mm.

Station 3687. Tahiti: off Point Venus, 4.8 miles. 725 fms. Bott. temp.? Vol. s., yl. m.

Station 4631. Panama: off Mariato Point, 72 miles. 774 fms. Bot. temp. 38°. Gn. s.

Station 4654. Peru: off Aguja Point, 24 miles. 1036 fms. Bott. temp. 37.3°. Dk. br. m.

Bathymetrical range, 725–1036 fms. Extremes of temperature, 38°–37.3°.

Eight specimens.

AMPHIURA GYMNOGASTRA.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 145, pl. 9, fig. 6–8.

These Amphiuras are perplexing, for while they have the interbrachial spaces below perfectly naked as in *A. gymnogastra*, there are only 3 or 4 arm-spines, and these are not small and sharply pointed as they should be, but are long, thick, and blunt as in some specimens of *A. serpentina*. In fact these specimens are quite intermediate between *A. gymnogastra* and *A. serpentina*. It is possible that they are hybrids, but more probably the two species are not distinct, the naked skin of the interbrachial areas in *A. gymnogastra* being a temporary condition due to peculiarities of breeding or possibly a stage of extreme maturity. The differences in the arm-spines of the two nominal species is not constant, specimens of *A. serpentina* with 5 small, sharp arm-spines being known.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

Five specimens.

AMPHIURA SEMINUDA.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 148, pl. 11, fig. 1–3.

These specimens, with disks about 5 mm. across, are in poor condition, but there is no question as to their identity.

Station 3689. Paumotu Islands: 4 miles southwest of northwest point of Marokau. 807 fms. Bott. temp. 37.6°. Co. s., mang.

Two specimens.

AMPHIPHOLIS GRANULATA.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 155, pl. 10, fig. 1–4.

Although this little specimen (disk-diameter 3 mm.) was taken by the ALBATROSS in 1891, it is from a station from which the species was not previously recorded.

Station 3389. Off Panama, 7° 16′ 45″ N., 79° 56′ 30″ W., 210 fms. Bott. temp. 48.8°. Gn. m.

One specimen.

AMPHIOPLUS DALEA.

Amphiura dalea Lyman, 1879. Bull. M. C. Z., **6**, p. 27. 1882. Challenger Oph., pl. 18, fig. 11–13.
Amphioplus dalea Verrill, 1899. Trans. Conn. acad., **10**, p. 315.

Although the type-locality for this species is in the southwestern Atlantic, it has been recorded twice from the Eastern Tropical Pacific. These specimens are not noteworthy in any particular save that they are mostly adults (disk-diameter 5–13 mm.) and are very well preserved.

Station 4649., Eastern Tropical Pacific, 5° 17′ S., 85° 20′ W., 2235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4670. 105 miles northeast of Palominos Light House, Peru. 3209 fms. Bott. temp. 35.4°. Fne. dk. br. m.

Sixty specimens.

AMPLIOPLUS LAEVIS.

Amphiura laevis Lyman, 1874. Bull. M. C. Z., **3**, p. 229, pl. 4, fig. 18–21.
Amphioplus laevis Verrill, 1899. Trans. Conn. acad., **10**, p. 315.

There is a single specimen of this fine species from Taritari, Gilbert Islands. The disk is nearly 6 mm. across and the arms about 65 mm. long.

OPHIOTRICHIDAE.

OPHIOTHRIX DEMESSA.

Lyman, 1861. Proc. Boston soc. nat. hist., **8**, p. 82. Koehler, 1905. Siboga-Exp. Oph. litt., pl. 9, fig. 5, 6.

Most of the specimens are small and in poor condition, but there is no mistaking this characteristic Pacific species.

Paumotu Islands: Makemo. Fakarava.

Thirteen specimens.

OPHIOTHRIX GALAPAGENSIS.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 181, pl. 20, fig. 1–4.

These are very typical specimens, with disks 5–7 mm. across.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

Three specimens.

OPHIOTHRIX LONGIPEDA.

Ophiura longipeda Lamarck, 1816. Anim. sans vert., **2**, p. 544.
Ophiothrix longipeda Müller and Troschel, 1842. Syst. Ast., p. 113.

There is a single specimen from Papeete, Tahiti, of this well-known species and two others with only the label "35". The significance of this number is unknown.

OPHIOTHRIX SPICULATA.

Leconte, 1851. Proc. Acad. nat. sci. Philadelphia, **5**, p. 318.

These specimens range in disk-diameter from 4 to 7 mm. and are quite typical of the species.

Panama: Perico Island. Tobaquilla Island.

Fifteen specimens.

OPHIOTHRIX TRILINEATA.

Lütken, 1869. Add. ad hist. Oph., pt. 3, p. 58, 100.

These are very typical specimens of this handsome and wide-spread species, but all are small, the disk-diameter ranging from 3 to only 6 mm.

Paumotu Islands: Makemo. Fakarava.

Thirty-four specimens.

OPHIOCHITONIDAE

OPHIONEREIS ANNULATA.

Ophiolepis annulata Leconte, 1851. Proc. Acad. nat. sci. Philadelphia, **5**, p. 317.
Ophionereis annulata Lyman, 1860. Proc. Boston soc. nat. hist., **7**, p. 203.

These specimens are adults, with disks 7–8 mm. across. The one from Perico has the ground-color distinctly olive-green, while in the other specimens it is very light brown.

Panama: Perico Island. Tobaquilla Island.

Three specimens.

OPHIONEREIS PORRECTA.

Lyman, 1860. Proc. Boston soc. nat. hist., **7**, p. 260. 1865. Illus. cat. M. C. Z., no. 1, p. 147, fig. 14, 15.

These specimens range from 3 to 9 mm. across the disk.

Paumotu Islands: Makemo.

Marshall Islands: Jaluit.

Three specimens.

OPHIOCOMIDAE.

OPHIOCOMA AETHIOPS.

Lütken, 1859. Add. ad hist. Oph., pt. 2, p. 141, 145.

There are a dozen specimens of this well-known species from Perico Island, Panama.

OPHIOCOMA ALEXANDRI.

Lyman, 1860. Proc. Boston soc. nat. hist., **7**, p. 256.

There are nine specimens of this species from Perico Island, Panama.

OPHIOCOMA BREVIPES.

Peters, 1851. Monats. K.-Preus. akad. wiss. Berlin, p. 465.

The species of Ophiocoma with two tentacle-scales and a very finely granulated disk are very perplexing. Whether we are dealing with one, two, or three species is still uncertain. For the present, I think it best to distinguish two species, *O. brevipes* and *O. insularia*, and under the latter name, a typical form and a long-spined variety. This, at least, is the division best adapted to the present collection. The coloration of *O. brevipes* is its conspicuous character and seems to be quite constant; there is a ground-color of very pale yellowish white with a distinctly greenish cast, and this is more or less marked with blotches and streaks of dusky or greenish; on the arms these darker markings are chiefly apparent as transverse bands; the arm-spines usually show spots or markings of dusky. As a rule, the arm-spines of *O. brevipes* are shorter and less flattened than those of *O. insularia.*

Paumotu Islands: Makemo. Fakarava.

Seventeen specimens.

Ophiocoma erinaceus.

Müller and Troschel, 1842. Syst. Ast. p. 98.

The specimens are all small, the largest having a disk only 15 mm. across.

Paumotu Islands: Makemo. Fakarava.

Seventeen specimens.

Ophiocoma insularia.

Lyman, 1861. Proc. Boston soc. nat. hist., **8**, p. 80.

The specimens here listed as *O. insularia* differ from *O. brevipes* only in size, color, and arm-spines. They are from 10 to 22 mm. across the disk, of very dark shades of brown, and with long, flattened arm-spines. One specimen (from Papeete) is uniformly deep purplish brown above and light wood-brown below. All the other specimens, save one, have the arms more or less banded with dull yellowish on the brown background, and even the disk may be variegated with dull yellowish, or the specimens are variegated with light and dark shades of brown. The one exception is from Easter Island and differs so much from the other specimens that I propose to call it variety *longispina.* In coloration it is uniformly blackish brown like *O. erinaceus*, but the *granulations* are very fine and the tentacle-scales are narrow and pointed. It differs from typical *O. insularia* in two important particulars. The jaws are moderately long with very evident oral plates, while in *O. insularia* the jaws are very short and wide with almost no oral plates. The arm-spines of which there may be five are exceedingly long and slender, 5–6 mm. long and equal to four or five arm-segments. As the arm-spines of Ophiocoma are excessively variable and unreliable, this may be only an individual peculiarity, but it profoundly affects the appearance of the specimen.

Tahiti: Papeete. Three specimens.

Easter Island. Twelve specimens.

OPHIOCOMA PARVA.

H. L. Clark, 1915. Mem. M. C. Z., **25**, p. 292, pl. 14, fig. 8, 9.

These specimens show little diversity and agree well with the original specimens from Torres Strait.

Paumotu Islands: Makemo. Fakarava.

Twenty-eight specimens.

OPHIOCOMA PICA.

Müller and Troschel, 1842. Syst. Ast., p. 101.

The specimens of this beautiful species are small, only 7–11 mm. across the disk.

Paumotu Islands: Makemo.

Three specimens.

OPHIOCOMA SCOLOPENDRINA.

Ophiura scolopendrina Lamarck, 1816. Anim. sans vert., **2**, p. 544.
Ophiocoma scolopendrina Müller and Troschel, 1842. Syst. Ast., p. 101.

There is nothing notable about the series of this common and well-known species.

Paumotu Islands: Makemo. Fakarava. Rangiroa.

Seventeen specimens.

OPHIOMASTIX BISPINOSA, sp. nov.

Plate **2**, fig. 1, 2.

Disk, 5 mm. in diameter; arms about 40–45 mm. long. Disk covered with a thick skin completely concealing the scales; scattered irregularly over the dorsal side of the disk are about 60 small, slender spinelets scarcely half a millimeter long. No radial shields visible. Upper arm-plates oval, the greatest width *proximal* to middle; the outlines are obscured by the skin in which they seem to lie. Interbrachial areas below smooth, apparently naked save for a few small spinelets near margin. Oral shields oval, about as wide as long, the greatest width distal to middle. Adoral plates and oral plates small and more or less concealed by skin. Oral papillae 3 or 4 on each side, the distalmost largest. Tooth-papillae only 3–5 on each jaw tip. Under arm-plates tetragonal with slightly rounded corners, longer than wide, little or not at all in contact. Side arm-plates moderately large, meeting below; each carries 2 or 3 prominent spines; when 3 are present, the uppermost is largest and is often very large, its length equalling 2–3 arm-segments and its thickness proportionately great; near the middle of the arm, segments with two or with three spines alternate with considerable regularity; the big uppermost spines occur at intervals of 2–5 segments and alternate on the two sides of the arm. Tentacle-scale single, small and rounded. Color (dried):—disk dull light olive with a very few lighter markings; disk-spines dull yellowish; upper arm-plates dull olive but at intervals of 4–6 segments, the upper arm-plate is dull cream-color; upper half of side arm-plates and uppermost spines, usually dull olive but when upper arm-plate is cream-color the adjoining side arm-plate and the uppermost spine it carries is usually the same; lower surface of disk and arms, including smaller arm-spines very pale brown; some arm-spines more or less distinctly annulated with dusky or olive.

Paumotu Islands: Makemo.

One specimen.

Although this specimen is obviously immature, it differs so much from previously known members of the genus, it is necessary to designate it by a new name. The name given is based on one of the striking features, the presence of only two arm-spines on many of the side arm-plates. This character taken in connection with the disk-covering, the upper arm-plates and the coloration will serve to distinguish the species at once from all other members of the genus.

OPHIODERMATIDAE.

OPHIODERMA PANAMENSE.

Lütken, 1859. Add. ad hist. Oph., pt. 2, p. 91.

Two specimens from Perico Island, Panama, call for no comment.

OPHIODERMA PENTACANTHA,[1] sp. nov.

Plate **3**; Plate **4**, fig. 1, 2.

Disk, 27 mm. in diameter; arms 145–150 mm. long. Disk covered with the usual coat of coarse, overlapped scales, completely concealed by the smooth uniform layer of fine granules, about 150 to a square millimeter. Radial shields entirely concealed. Upper arm-plates tetragonal, becoming almost triangular at very tip of arm, where they are as long as wide; on basal portion of arm they are 3–4 times as wide as long and cover the entire dorsal surface of arm. Basal half of arm distinctly keeled, though the keel is low and rounded. Interbrachial areas below uniformly covered with the fine coat of granules of disk. Genital slits four in each interbrachial area. Oral shields triangular with very rounded angles, a trifle wider than long. Adoral plates very small, bare, at distal corners of oral shields. Oral plates completely concealed by granules. Oral papillae 9–10 on each side, the two distalmost and the most proximal one, largest; far up in the mouth-slit, on the side of each jaw is a conspicuous pointed papilla as large as the largest of the oral papillae. Teeth about five. No true tooth-papillae. Under arm-plates at first hexagonal with strongly convex distal side which soon develops angles, making the plate octagonal; on basal half of arm, the plates are much wider than long; distally they become tetragonal with rounded corners and ultimately they are longer than wide. Side arm-plates low and small; each carries 5 rather stout, flat, blunt arm-spines, of which the uppermost is smallest, about half as long as side arm-plate, and the lowest is conspicuously largest, much exceeding the plate; on distal part of arm there are of course only 4, and then 3 arm-spines. Tentacle-scales 2, the inner narrower than the outer and very much longer, commonly longer than the side of the under arm-plate which it adjoins; outer scale flat and truncate, overlying the base of the lowest arm-spine. Color (dried): — light and dark brown, with a slight grayish cast; disk with dark blotches on a lighter background; arms more or less distinctly banded; under surface of disk fawn-color, of arms nearly white, except distally.

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[1] πέντε = five + ἄκανθα = a spine, in reference to the five arm-spines.

Station 4643. Galapagos Islands: Hood Island, 5 miles southwest of Ripple Point. 100 fms. Bott. temp. 67.2°. Brk. sh., glob.

Five specimens.

This fine species, one of the most easily recognized in the genus, is indeed an interesting discovery. It resembles *O. elaps* of the West Indian region more nearly than it does any other species, but is at once distinguishable from that form by the small number of arm-spines. As a characteristic species of the Galapagos region, *Ophioderma pentacantha* will probably be entitled to high rank.

OPHIOPEZELLA SPINOSA.

Ophiarachna spinosa Ljungman, 1867. Öfv. Kongl. vet.-akad. Förh., **23**, p. 305.
Ophiopezella spinosa Lyman, 1882. Challenger Oph., p. 17.

The specimens are all young and quite small but the identity seems clear.

Paumotu Islands: Makemo. Fakarava. Rangiroa.

Society Islands: Tahiti, Papeete.

Four specimens.

OPHIOLEPIDIDAE.

AMPHIOPHIURA ABCISA.

Ophioglypha abcisa Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 117, pl. 2, fig. 1–3.
Amphiophiura abcisa Matsumoto, 1915. Proc. Acad. nat. sci. Philadelphia, **67**, p. 78.

The specimen is in poor condition but its identity seems fairly certain.

Station 4705. Eastern Tropical Pacific, 15° 05′ S., 99° 19′ W., 2031 fms. Bott. temp. 35.3°. Lt. yl. br. glob. oz.

One specimen.

OPHIURA FLAGELLATA.

Ophioglypha flagellata Lyman, 1878. Bull. M. C. Z., **5**, p. 69. 1882. Challenger Rep., pl. 4, fig. 16–18.
Ophiura flagellata Meissner, 1901. Bronn's Thierreichs, **2**, abt. 3, p. 925.

The specimens are adults with the arms all badly broken.

Station 4641. Galapagos Islands: Hood Island, 12 miles southeast of Ripple Point. 633 fms. Bott. temp. 39.5°. Lt. gy. glob. oz.

OPHIURA IRRORATA.

Ophioglypha irrorata Lyman, 1878. Bull. M. C. Z., **5**, p. 73. 1882. Challenger Oph., pl. 5, fig. 7–9.
Ophiura irrorata Meissner, 1901. Bronn's Thierreichs, **2**, abt. 3, p. 925.

A good series, mostly in good condition. In size the specimens range from young ones, only 2.5–6 mm. across the disk, to adults

15–20 mm. across. There is some diversity in the scaling of the disk, in the size of the radial shields and in the basal under arm-plates, but the differences are relatively unimportant.

Station 3684. Eastern Tropical Pacific, 50′ N., 137° 45′ W., 2463 fms. Bott. temp.? Gy. yl. glob. oz.

Station 4647. Eastern Tropical Pacific, 4° 33′ S., 87° 42′ 30″ W., 2005 fms. Bott. temp. 35.4°. Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, 5° 17′ S., 85° 20′ W., 2235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4651. West of Aguja Point, Peru, 111 miles. 2222 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4658. West of Peru, 8° 30′ S., 85° 36′ W., 2370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Station 4670. West of Palominos Light House, Peru, 105 miles. 3209 fms. Bott. temp., 35.4°. Fne. dk. br. m.

Station 4672. Southwest of Palominos Light House, Peru, 88 miles. 2845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Station 4742. Eastern Tropical Pacific, 4′ S., 117° 7′ W., 2320 fms. Bott. temp. 34.3°. Fne. lt. gy. glob. oz.

Bathymetrical range, 2005–3209 fms. Extremes of temperature, 35.4°–34.3°.

Forty-eight specimens.

OPHIURA STENOBRACHIA,[1] sp. nov.

Plate **5**, fig. 1, 2.

Disk 9 mm. in diameter; arms all broken but it seems improbable that they exceeded 18–20 mm.; they are very slender only 1.3 mm. in diameter at base. Disk covered by about 150–200 plates among which the primaries can scarcely be distinguished; the disk is highly arched, its thickness at center being nearly 3 mm.; the margin of each interradial area is nearly or quite fully occupied by a single large plate, little of which, however, is visible from above. Radial shields moderately large, roughly triangular, nearly or quite as wide as long, in contact at outer ends but well separated within. Arm-comb small, not extending well up on to the upper surface of the arm, composed of few, flat, blunt, close-set papillae, of which the uppermost are largest. Upper arm-plates triangular, exceedingly small, about as long as wide, separated (except on the first two basal seg-

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[1] στενός = narrow + βραχἱων = arm, in reference to the very slender arms.

ments) by a distance greater than their own length. Interbrachial areas below covered by about half a dozen large plates, with sometimes a few much smaller ones among them. Oral shields very similar in appearance to these interbrachial plates, broadly triangular or pentagonal; in one specimen they are as long as wide or longer, while in the other they are distinctly wider than long. Adoral plates very long, straight, and narrow. Oral plates also long and narrow, but shorter and perhaps wider than adorals. Oral papillae about 8 on each side, very small, subequal. First under arm-plate nearly twice as wide as long, its proximal side very short, like a truncated angle; second plate larger, more swollen, and more nearly rectangular; third plate about like first; succeeding plates smaller and smaller, nearly or quite three times as wide as long; no two of the under arm-plates are in contact and the distal ones are very widely separated. Side arm-plates long and relatively large, meeting broadly both above and below; they are larger distally than proximally, so that the arm seen from either above or below has a wavy outline; each side arm-plate bears 3 short, sharp, subequal spines about half as long as the plate; these spines are borne on the lower half of the distal margin of the plate. Oral tentacle-pores open on face of jaw, entirely outside of mouth-slits; they have 4 or 5 scales on each side. Tentacle-pores of first arm-segment similar but somewhat smaller, with 3 or 4 tentacle-scales on each side. Tentacle-pore of second arm-segment, much smaller guarded by 2 scales or only 1. Succeeding pores very small and guarded by a single minute scale. Color (dried): — very pale brown.

Station 4647. Eastern Tropical Pacific, 4° 33′ S., 87° 42′ 30″ W. 2005 fms. Bott. temp. 35.4°. Lt. gy. and br. glob. oz.

Two specimens.

These specimens are not in good condition, but the specific characters are obvious. The highly arched disk covered by numerous plates, the very slender arms with remarkably reduced upper and under arm-plates, and the reduced condition of the tentacle-pores make an unusual combination, and gives this Ophiura a very characteristic facies.

OPHIURA UNDULATA.

Ophioglypha undulata Lyman, 1878. Bull. M. C. Z., **5**, p. 75. 1882. Challenger Oph., pl. 5, fig. 10–12.

Ophiura undulata Meissner, 1901. Bronn's Thierreichs, **2**, abt. 3, p. 925.

In the Catalogue of recent ophiurans (Mem. M. C. Z., **25**) I referred this species to *O. irrorata* as a synonym. The CHALLENGER specimen was the only one known and it seemed probable that it was merely an individual variant of the widely distributed and variable *O. irrorata.* The ALBATROSS specimens have convinced me that I was wrong and that *O. undulata* is a good species. The coarser disk-scaling and the stout arm-spines are very characteristic. Lyman's figures are excellent, but in the specimens before me the disk-scales are more regularly arranged than in his type. The large plates are surrounded by smaller ones in a somewhat ornate pattern. In one specimen, the primary plates are very distinct. In these individuals the disk is 14 mm. across, so they are somewhat larger than the CHALLENGER specimen.

Station 3689. Paumotu Islands: Marokau, 4 miles west of northwest point. 807 fms. Bott. temp. 37.6°. Co. s., mang.

Two specimens.

OPHIOMUSIUM CANALICULATUM,[1] sp. nov.

Plate **5**, fig. 5–8.

Disk, somewhat highly arched, 8 mm. in diameter, rather more than 2 mm. high; arms all broken, slender, apparently about 25 mm. long. Disk covered by the six primary plates, the large radial shields and two additional plates in each interradius, the lower one of these two forming the margin of the disk; three very small plates occur in interstices between large plates. Radial shields moderately large, larger than any of the primary plates, in contact with each other for almost their full length. All the disk-plates are shagreened. Upper arm-plates *none,* unless a minute triangular plate between the distal ends of the radial shields be construed as such. Interbrachial areas below covered by 2 (in one interradius 3) plates, in addition to the wide but very short marginal plate. Oral shields diamond-shaped, somewhat wider than long; in the interradius with 3 plates in the interbrachial area the distal angle of the oral shield is truncate, causing the shield to become pentagonal. Adoral plates well developed but not large, about 2.5 times as long as wide. Oral plates somewhat shorter and a little wider. Oral papillae very indistinct, apparently six or seven, but all fused into a narrow marginal piece along the oral slits. First under arm-plate minute and indistinct, apparently longer than wide; second under arm-plate, slightly

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[1] *Canaliculatus* = grooved, in reference to the deep median, longitudinal furrows on the arms.

pentagonal or almost triangular, about .40 mm. long and not quite so broad; third similar but smaller; beyond the third segment there are no under arm-plates. Side arm-plates relatively very large, meeting completely both above and below. Along the median line, on both the upper and lower surfaces of the arm, is a conspicuous longitudinal groove or furrow. Each side arm-plate bears 3 or 4 very minute, sharp spinelets of rather unequal size; the largest are not equal to one third the length of the segment. Tentacle-pores present only in connection with the second and third under arm-plates; they are very minute, lie near the proximal angle (or side) of the plate, and have no tentacle-scales. Entire under surface of animal shagreened. Color (dried): — very pale brown.

Station 4732. Eastern Tropical Pacific, 16° 32′ 30″ S., 119° 59′ W., 2012 fms. Bott. temp. 34.8°. Glob. oz.

One specimen.

The remarkable reduction in the number of plates composing the disk and arms of this Ophiomusium is really notable. Without upper and under arm-plates (save on the lower side of two basal joints), with no tentacle-scales, and with a disk composed of only about 65 plates, the species is not likely to be confused with any of those hitherto known.

OPHIOMUSIUM GLABRUM.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 132, pl. 4, fig. 7–9.

The present large series seems to show that this is the characteristic brittle-star of the deep waters of the Eastern Tropical Pacific. The specimens range from 5 to 33 mm. across the disk.

Station 4647. Eastern Tropical Pacific, 4° 33′ S., 87° 42′ 30″ W., 2005 fms. Bott. temp. 35.4°. Lt. gy. and br. glob. oz.

Station 4649. Eastern Tropical Pacific, 5° 17′ S., 85° 20′ W., 2235 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4651. West of Aguja Point, Peru, 111 miles. 2222 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

Station 4656. West of Peru, 6° 55′ S., 83° 34′ W., 2222 fms. Bott. temp. 35.2°. Fne. gn. m., mang. nod.

Station 4658. West of Peru, 8° 30′ S., 85° 36′ W., 2370 fms. Bott. temp. 35.3°. Fne. gn. m., mang. nod.

Station 4666. West of Peru, 11° 55′ S., 84° 20′ W., 2600 fms. Bott. temp. 34.9°. Fne. gy. rad. oz.

Station 4672. Southwest of Palominos Light House, Peru, 88 miles. 2845 fms. Bott. temp. 35.2°. Fne. dk. br. infus. m.

Station 4717. Eastern Tropical Pacific, 5° 11′ S., 98° 56′ W., 2153 fms. Bott. temp. 35.2°. Rd. c., glob. oz.

Station 4721. Eastern Tropical Pacific, 8° 7′ 30″ S., 104° 10′ W., 2084 fms. Bott. temp.? Lt. br. glob. oz.

Station 4732. Eastern Tropical Pacific, 16° 32′ 30″ S., 119° 59′ W., 2012 fms. Bott. temp. 34.8°. Glob. oz.

Station 4740. Eastern Tropical Pacific, 9° 2′ S., 123° 20′ W., 2422 fms. Bott. temp. 34.2°. Dk. gy. glob. and rad. oz.

Station 4742. Eastern Tropical Pacific, 4′ S., 117° 7′ W., 2320 fms. Bott. temp. 34.3°. Fne. lt. gy. glob. oz.

Bathymetrical range, 2005–2845 fms. Extremes of temperature, 35.4°–34.2°.

One hundred and forty specimens.

OPHIOMUSIUM JOLLIENSE.

McClendon, 1909. Univ. Cal. publ. Zool., **6**, p. 36, pl. 1, fig. 2, 3.

These specimens are very young, with disks little more than 4 mm. across, but their identity seems sure.

Station 4641. Galapagos Islands: Hood Island, 12 miles southeast of Ripple Point. 633 fms. Bott. temp. 39.5°. Lt. gy. glob. oz.

OPHIOMUSIUM LYMANI.

Wyville Thomson, 1873. Depths of the sea, p. 172, fig. 32, 33.

It is remarkable that no specimens of this common and very widespread deep water brittle-star were taken by the ALBATROSS on either the 1899–1900 nor the 1904–05 expedition. The present specimens are very young and were taken in 1891.

Station 3407. Galapagos Islands: northeast of Albemarle Island. 885 fms. Bott. temp. 37.2°. Glob. oz.

Station 3431. Gulf of California, 23° 59′ N., 108° 40′ W., 995 fms. Bott. temp. 37°. Lt. bn. m.

Two specimens.

Ophiomusium tripassalotum,[1] sp. nov.

Plate 5, fig. 3, 4.

Disk, little arched, 6.5 mm. across; arms very slender about 33 mm. long. Disk covered by about 50 rather small plates, slightly swollen around the margins, among which the primary plates can be distinguished; a large marginal plate in each interradius, with a smaller plate directly above it are much the largest of the disk-plates. Radial shields large, distinctly longer than wide (but scarcely equal to one half radius), broadly in contact, but at distal end separated very slightly by a small triangular plate. On each side of this plate is a smaller, transversely elongated, conspicuously swollen plate, the three forming a noticeable group at the base of each arm. Upper arm-plates minute, triangular, very widely separated, but remarkably persistent, present nearly or quite to the tip of the arm. Entire upper surface of disk and arms quite smooth, not at all shagreened. Interbrachial areas below covered by 6–12 smooth, irregular plates of very diverse sizes and arrangement. Oral shields pentagonal, longer than wide. Adoral plates long, straight, and narrow, the length fully 3–4 times the width. Oral plates evident, but much smaller than adorals. Oral papillae 5–7 on each side, very low and wide and not very distinct; the distal ones are widest. First under arm-plate minute about twice as long as wide; second under arm-plate much larger, shield-shaped but greatly elongated; it is widest distally, but even there is not half as wide as its length; third under arm-plate small not much longer than wide; no under arm-plates beyond third arm-segment. Side arm-plates relatively large and long, considerably swollen proximally, meeting fully above and below, but with no trace of a longitudinal groove on either surface of arm; each plate carries, on its lower distal corner, 3 small, blunt, subequal, peg-like arm-spines, about one fourth as long as arm-segment. Tentacle-pores present on arms only beside the proximal part of the under arm-plates on the second and third segments; each is provided with a large tentacle-scale. Color (dried):— very light, nearly white.

Station 3690. Paumotu Islands: 2 miles west of Hao Atoll. 812 fms. Bott. temp. 37.6°. Co. s.

One specimen.

The persistence of the upper arm-plates, while the under ones are lacking, combines with the non-shagreened and rather numerous disk-plates, and the small, grouped arm-spines to give this species a very characteristic facies. It does not seem to be very nearly related to any previously known species.

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[1] τρεῖς = three + πάσσαλος = a peg, in reference to the three peg-like arm-spines.

OPHIOZONELLA CLYPEATA.

Ophiozona clypeata Lyman, 1883. Bull. M. C. Z., **10**, p. 234, pl. 3, fig. 13–15.
Ophiozonella clypeata Matsumoto, 1915. Proc. Acad. nat. sci. Philadelphia, **67**, p. 82.

I have hesitated referring this specimen to the West Indian species, *O. clypeata*, but it is fully adult (10 mm. across the disk) and in excellent condition and I can find no valid reason for giving it a new name. It differs slightly from the type of *O. clypeata* in the scaling of the disk and in the shape of the oral shields, but these differences are so trifling that one cannot seriously consider them as due to anything more than individual diversity.

Station 4642. Galapagos Islands: Hood Island, 4 miles southeast of Ripple Point. 300 fms. Bott. temp. 48.6°. Brk. sh., glob.

One specimen.

OPHIOTYPA SIMPLEX.

Koehler, 1897. Ann. sci. nat. Zool., ser. 8, **4**, p. 281, pl. 5, fig. 1–3.

It is a matter of considerable interest to find this very remarkable brittle-star in the eastern Pacific. It is known from the Indian Ocean and from the eastern Atlantic, so it seems probable that it is cosmopolitan. These specimens are of full size and well preserved, but show no noteworthy features of their own.

Station 4721. Eastern Tropical Pacific, 8° 7′ 30″ S., 104° 10′ W., 2084 fms. Bott. temp.? Lt. br. glob. oz.

Two specimens.

OPHIOLEUCIDAE.

OPHIERNUS ANNECTENS.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 107, pl. 5, fig. 4–6.

The specimens are in very bad condition but there is no reason to doubt their identity.

Station 4641. Galapagos Islands: Hood Island, 12 miles southeast of Ripple Point. 633 fms. Bott. temp. 39.5°. Lt. gy. glob. oz.

Two specimens.

OPHIERNUS SEMINUDUM.

Lütken and Mortensen, 1899. Mem. M. C. Z., **23**, p. 105, pl. 5, fig. 10–12.

The specimens are fairly well preserved and are quite typical. They measure 10–15 mm. across the disk.

Station 4651. West of Aguja Point, Peru, 111 miles. 2222 fms. Bott. temp. 35.4°. Fne. stky. gy. m.

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Figs. 1, 2.— Asteroschema monobactrum H. L. Clark. × 3.
  1. Upper surface.
  2. Lower surface.

Figs. 3, 4.— Ophiacantha quadrispina H. L. Clark. × 2.
  3. Upper surface, to show upper arm-plates.
  4. Lower surface, to show mouth-parts, etc.

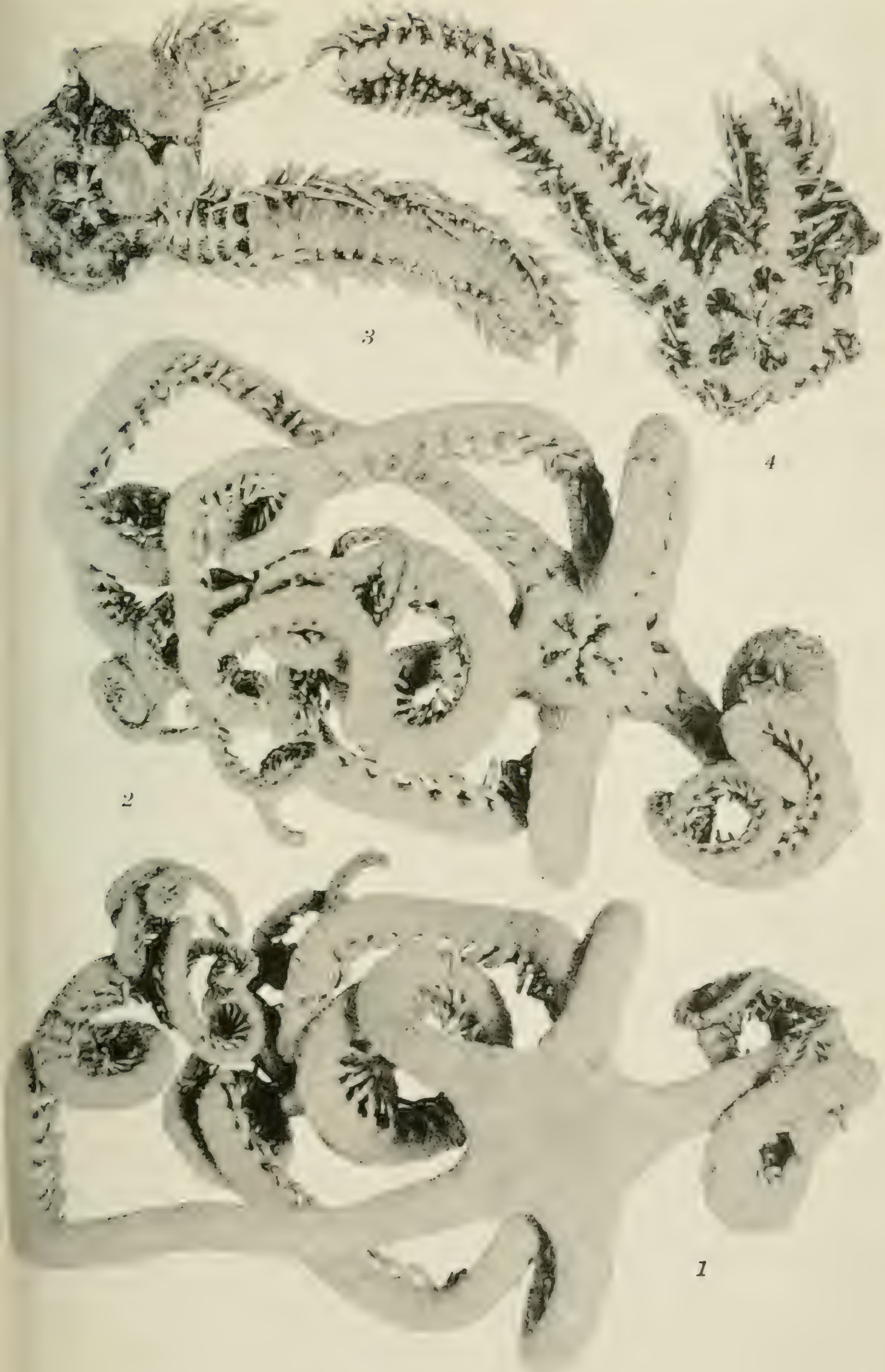
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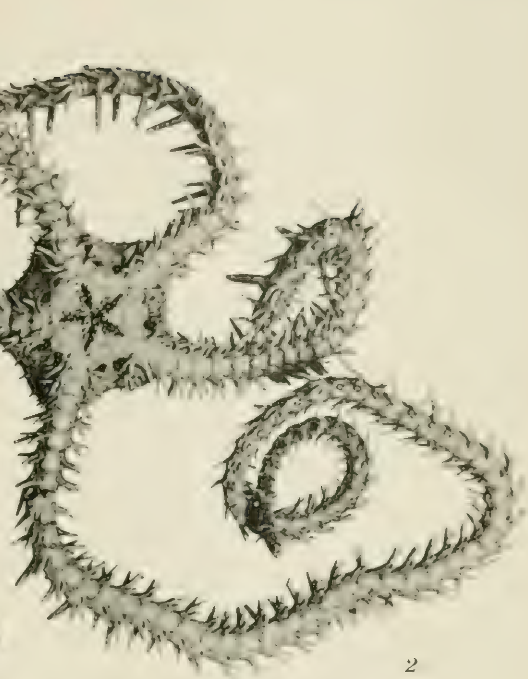
PLATE 2.

PLATE 2.

Figs. 1, 2.— Ophiomastix bispinosa H. L. Clark. × 4.
  1. Upper surface.
  2. Lower surface.

Fig. 3.— Ophiacantha quadrispina H. L. Clark. × 2.
  3. Upper surface of best-preserved disk.



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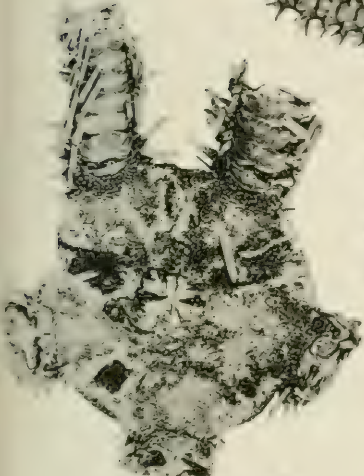

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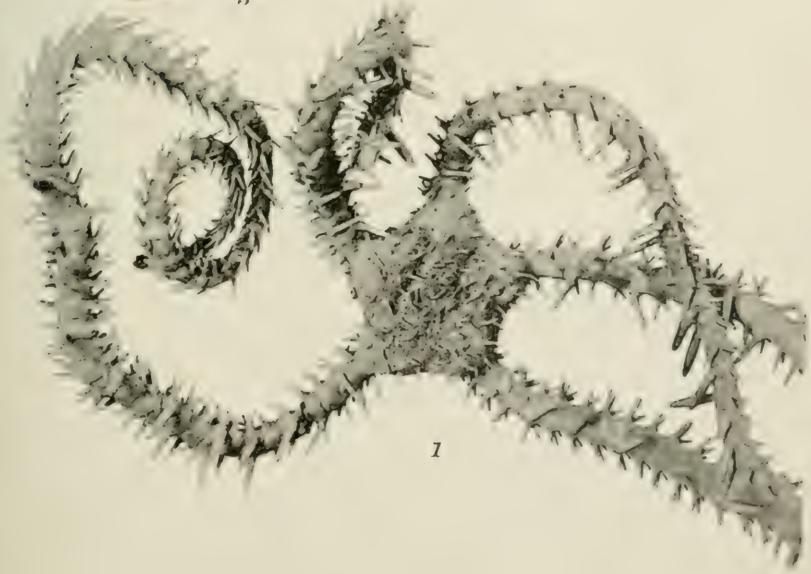

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PLATE 3.

PLATE 3.

Ophioderma pentacantha H. L. Clark. Nat. size. Upper surface.

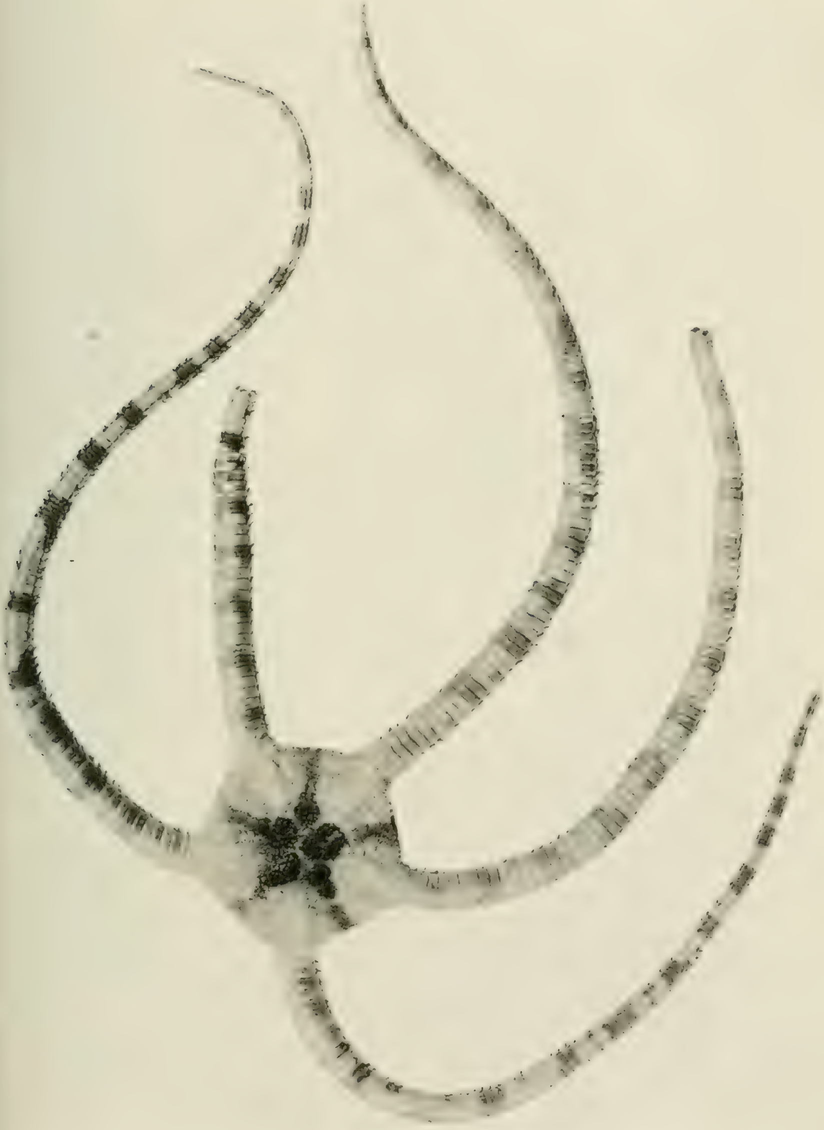
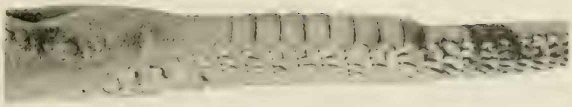


PLATE 4.

PLATE 4.

Figs. 1, 2.— Ophioderma pentacantha H. L. Clark.
1. Lower surface. Nat. size.
2. Side view of base of arm. × 2.5.



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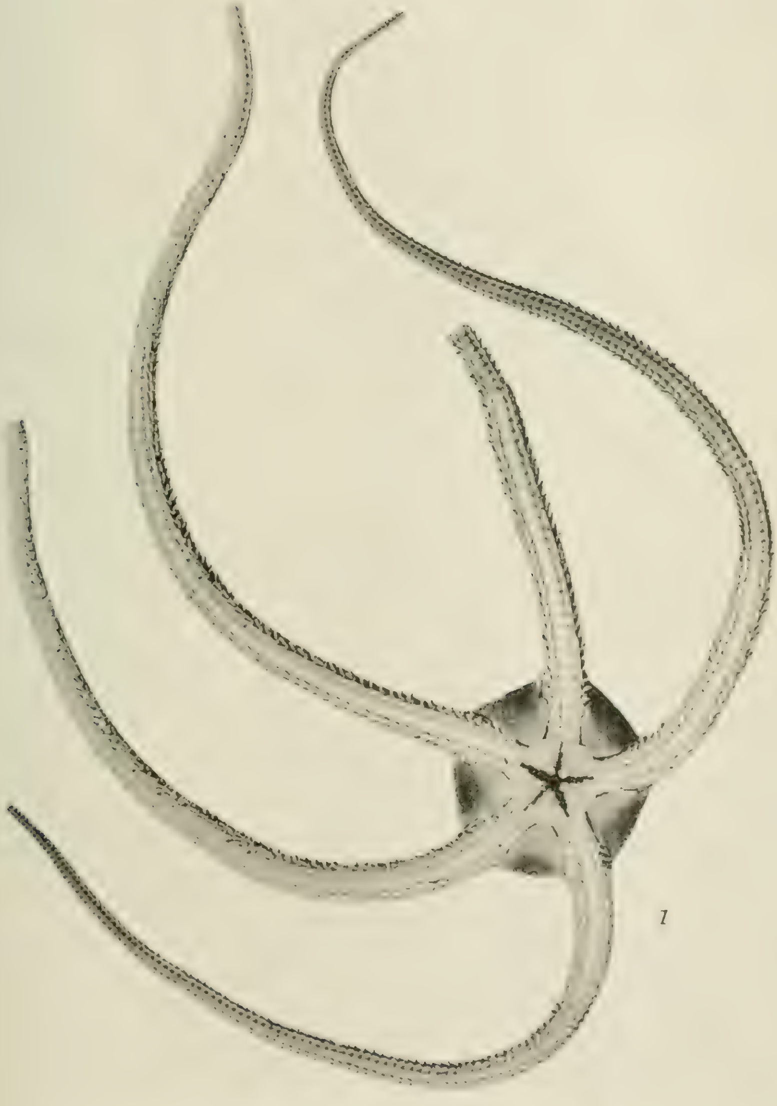

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PLATE 5.

PLATE **5**.

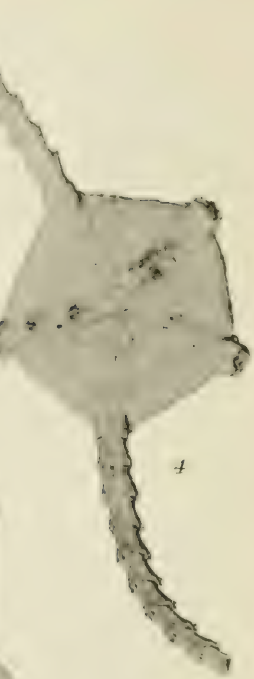
Figs. 1, 2.— Ophiura stenobrachia H. L. Clark. × 4.
1. Upper surface.
2. Lower surface of another specimen.

Figs. 3, 4.— Ophiomusium tripassalotum H. L. Clark. × 5.
3. Upper surface.
4. Lower surface.

Figs. 5–8.— Ophiomusium canaliculatum H. L. Clark. × 4.
5. Upper surface.
6. Lower surface.
7. Partly ventral view of basal portion of arm, to show the longitudinal furrow.
8. Side view of basal portion of arm.

8

7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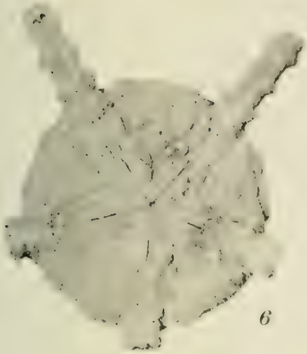
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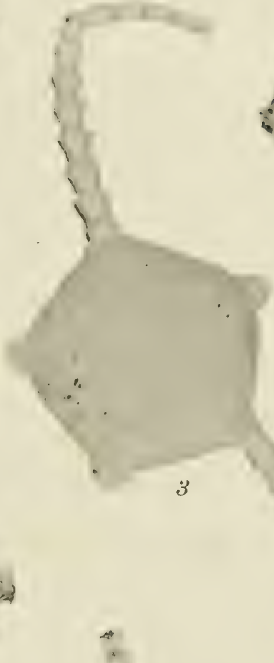
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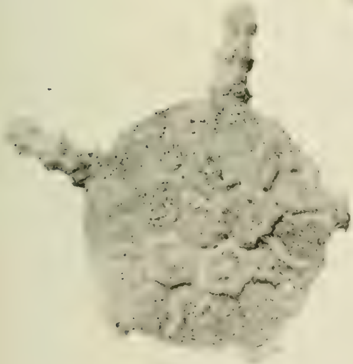
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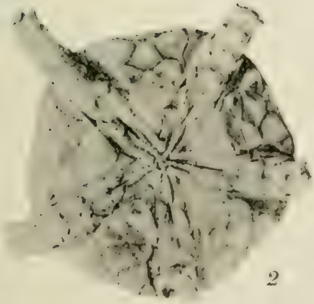
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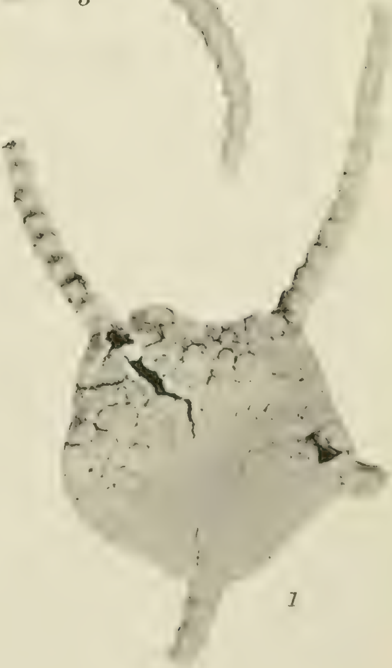
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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LXI. No. 13.

JAMAICAN ANTS COLLECTED BY PROF. C. T. BRUES.

BY WILLIAM MORTON WHEELER.

WITH TWO PLATES.

CAMBRIDGE, MASS., U. S. A.
PRINTED FOR THE MUSEUM.
DECEMBER, 1917.

No. 13.— *Jamaican Ants collected by Prof. C. T. Brues.*

By William Morton Wheeler.

CONTRIBUTIONS FROM THE ENTOMOLOGICAL LABORATORY OF THE BUSSEY INSTITUTION, HARVARD UNIVERSITY, NO. 130.

A fine series of ants recently collected in Jamaica by Professor Brues is of unusual interest because most of them were taken in new localities and comprise several forms new to science or unrecorded in my papers on Jamaican ants published in 1908, 1911, and 1913. There are also a few new records in Forel's paper of 1912 on the neotropical ants. I have included these, prefixing all the new records with an asterisk. With the additions and a few changes in nomenclature necessitated by the study of more abundant material, some 70 species, subspecies, and varieties of Formicidae are now known from Jamaica.

1. *Platythyrea punctata* (F. Smith) var. *pruinosa* Mayr. ☿ —Montego Bay (Amer. Mus. Coll.).

Forel has shown that the form of this species occurring in Jamaica is the var. *pruinosa* and not the typical form.

2. *Ectatomma* (*Holcoponera*) *striatulum* Mayr. ☿.— Newton, 3,000 ft.; Kingston.

The series from the former locality comprises 28 workers, from the latter a single specimen which is smaller, more reddish, with less pronounced mesoëpinotal angle in profile and longer spines on the hind coxae. It may represent a distinct subspecies, but the material is insufficient to justify the introduction of a new name.

3. *Euponera* (*Trachymesopus*) *stigma* (Fabricius). ☿.— Cinchona, 5,000 ft.
4. *Ponera opaciceps* Mayr. ☿ ♂.— Newton, 3,000 ft.
5. *Ponera trigona* Mayr. var. *opacior* Forel. ♀.— Newton, 3,000 ft.

*6. *Leptogenys puncticeps* Emery. ☿.— Newton, 3,000 ft.

Not hitherto recorded from Jamaica, though known from Grenada and resembling the form from that island in all respects. The types are from Costa Rica. Forel has described a subspecies *vincentensis* from the island of St. Vincent. It has the legs entirely red and the anterior clypeal projection and posteromedian projection of the petiole are less pointed than in the typical form.

7. *Odontomachus haematoda* (Linné) subsp. *insularis* Guérin. ☿.— Liguanea Plain.
8. *Odontomachus haematoda* subsp. *insularis* var. *ruginodis* Wheeler. ☿ ♀.— Newton, 3,000 ft.
9. *Pseudomyrma flavidula* F. Smith var. *delicatula* Forel. ☿.— Kingston.

*10. *Pseudomyrma eduardi* Forel. ☿.— Newton, 3,000 ft.

A single specimen agreeing perfectly with Forel's description.

11. *Monomorium carbonarium* F. Smith subsp. *ebeninum* Forel. ☿ ♀.— Kingston.
12. *Cardiocondyla emeryi* Forel. ♂.— Liguanea Plain.

A single specimen with the head darker and the epinotal spines somewhat longer than in specimens from other localities in my collection.

13. *Solenopsis geminata* (Fabr.). ☿ ♀ ♂.— Newton, 3,000 ft.; Liguanea Plain.
14. *Pheidole fallax* Mayr. ♃ ♀.— Newton, 3,000 ft.

*15. *Pheidole fallax* Mayr var. *ovalis* Forel.

According to Forel the soldier of this variety, which he recently described from Jamaica, differs from the typical *fallax* in having the head rather oval, with much more convex sides and much narrower behind. The occipital lobes are narrower, more prominent and more densely rugose. I refer specimens from Kingston (M. Grabham) to this variety, but other specimens from Balaclava (A. E. Wight) seem to be intermediate between it and the typical form.

16. *Pheidole rodoszkowskii* Mayr var. *opacissima* Forel. ♃ ☿.— Newton, 3,000 ft.
17. *Pheidole megacephala* (Fabr.). ♃.— Cinchona, 5,000 ft.
18. *Pheidole caribbaea* Wheeler. ♀.— Newton, 3,000 ft.

A single deälated specimen agreeing with the gynetypes taken by Wight at Balaclava, except that the body is somewhat more hairy like that of the following subspecies:

*19. *Pheidole caribbaea* subsp. *sloanei,* subsp. nov.

Soldier. Differing from the typical form in the following particulars:— the head is a little smaller, the sculpture of the head and especially of the thorax, pedicel, and gaster is distinctly feebler and more superficial, the occipital corners of the head being smooth and shining and the pronotum somewhat shining, though transversely rugose above. The rugae on the head lateral to the front are not longitudinal but reticulate, or at any rate indistinctly longitudinal, whereas they are sharply longitudinal in the typical form. The hairs on the body and appendages are longer and more abundant. The color is paler, the body and legs being dark brown throughout or with only the scapes and metanotum darker or blackish. The tarsi are yellowish as in the type.

Worker. Like the worker of the typical form but of a slightly paler brown color and with the hairs on the legs and scapes longer and less oblique and those on the head and thorax more numerous.

Female. Differing from the female of the typical *caribbaea* in nearly the same characters as the soldier. The occipital border of the head is shining, but the anteromedian shining streak on the mesonotum is somewhat less pronounced. Wings long, colorless, with dark brown pterŏstigma and very pale brown veins.

Described from eight soldiers, one worker, and three females taken at Newton, 3,000 ft.

*20. *Pheidole punctatissima* Roger subsp. *jamaicensis* Wheeler var. *barbouri* Wheeler. ♃ ☿.— Cinchona, 5,000 ft.

Almost indistinguishable from the types. Possibly imported with plants into Jamaica from Cuba.

21. *Pheidole flavens* Roger. ♃ ☿.— Kingston.

*22. *Pheidole floridana* Emery subsp. *stomachosa,* subsp. nov.

Soldier. Differing from the typical *floridana* in having distinctly longer antennae and the longitudinal rugae on the clypeus and anterior portion of the head more pronounced. They are also present lateral to the frontal carinae on the feeble scrobe-like depressions which are merely finely and densely punctate in *floridana.* The humeral angles and lateral conules of the postpetiole are more acute. The sculpture of the thorax is more pronounced but that of the petiole and postpetiole is feebler so that these segments are more shining. The gaster is opaque and finely punctate at the extreme base above. The head, thorax, pedicel, and gaster are chestnut-brown, the legs and antennae yellow. The pilosity is precisely like that of *floridana.*

Worker. Head and pronotum very smooth and shining, unlike the same parts in *floridana,* which are opaque and densely and finely punctate. The antennae are longer, the scapes extending beyond the occipital border of the head. The sparse, erect hairs on the body are blunt but not thickened as in *floridana.* The color is the same as that of the soldier.

Female (deälated). The head has the posterior corners shining but is otherwise opaque and with the longitudinal rugae sharp and extending to the posterior corners. Color like that of the soldier.

Described from numerous specimens of all three phases from Newton, 3,000 ft.

*23. *Pheidole* (*Ceratopheidole*) *hecate* Wheeler subsp. *bruesi,* subsp. nov.

Soldier. Differing from the subsp. *malevola* Wheeler as follows:— the head is somewhat smaller. The rugae on the front of the head are less pronounced, and the sides, lateral to the frontal carinae, are very smooth and shining, with only a few short rugae at the anterior border of the cheeks and a few indistinct rugae median to the eyes. The antennal scapes are longer, reaching the posterior corners of the head. The thorax is more shining, with the transverse rugae sharper and more regular and without the punctate interrugal spaces of *malevola.* The long epinotal spines are distinctly more curved and less erect. The color of the body and appendages is darker, being nearly black, the mandibles darker red, with black borders.

Worker. Differing from the worker *malevola* only in its darker color and in the epinotal spines, which like those of the soldier are more curved and less erect.

Described from six soldiers and 26 workers from Newton, 3,000 ft.

24. *Crematogaster steinheili* Forel. ☿.— Kingston.

Forel now regards this form as a distinct species and not as a variety of *victima* F. Smith.

25. *Crematogaster brevispinosa* Mayr subsp. *vicina* Ern. André. ☿ ♀ ♂.— Newton, 3,000 ft. (Brues); Kingston (E. A. Andrews, M. Grabham); Balaclava, Troy (A. E. Wight).

Forel regards this as a subspecies of *brevispinosa,* distinguished from the typical form by the absence of the tooth on the lower anterior surface of the petiole. The tooth is present, however, in the workers of some colonies, though very small. His statement that the antennal scapes reach the occipital border of the head does not agree with my observations. The material collected from the localities mentioned above shows that my var. *wighti* is untenable. André undoubtedly drew his color description of *vicina* from immature specimens, as I find two colonies in which part of the workers have the pale color he describes while others have the dark mature color on which I based the var. *wighti.* Different colonies also show considerable differences in the size of the workers, from 1.8 mm. to 3.5 mm.

The female measures 4.5–5.5 mm. and is very smooth and shining throughout, of a rich castaneous color, with the antennae and legs a little paler and the gaster nearly black. The antennal scapes do not reach to half the distance between the posterior orbits and the posterior corners of the head. The epinotal spines are reduced to minute, acute teeth and the petiole bears a vestige of a tooth at its anterior ventral border.

The male measures about 2 mm. and is sordid yellow, with the head and apex of the gaster dark brown, the clypeus and some clouds on the thorax pale brown. The wings are long and whitish hyaline, with colorless veins and pterostigma.

This ant constructs an interesting, more or less globular or turnip-shaped, black carton nest about four to six inches in diameter on trees and fences. The accompanying plates (Plates **1**, **2**) from photographs by Professor Brues give excellent views of its external and internal structure.

*26. *Cryptocerus* (*Cyathocephalus*) *varians* F. Smith.

Forel states that he took this species in the botanical garden at Kingston.

27. *Cyphomyrmex rimosus* (Spinola) subsp. *minutus* Mayr. ♂.— Liguanea Plain.

28. *Cyphomyrmex foxi* Ern. André. ☿ ♀.— Newton, 3,000 ft.

Numerous specimens from four colonies. The female, hitherto undescribed, is represented by a single, deälated individual. It measures 3.4 mm. and closely resembles the worker in color, sculpture, and pilosity and in the structure of the head. The spines on the humeri of the pronotum are long and stout. The mesonotum is flattened above, as broad as long, with a pair of low longitudinal welts anteriorly and expanded postero-lateral borders, bluntly dentate anteriorly and posteriorly. The scutellum is bluntly bidentate and projecting. The epinotum is abruptly declivous, without distinct base and declivity, and with a pair of longitudinal ridges terminating behind in large, blunt, compressed teeth. Between these ridges the surface is transversely rugose. The petiole is small and similar to that of the worker, the postpetiole very large, broader than long, subrectangular when seen from above, with two short, blunt, longitudinal ridges, terminating in large blunt projections behind and separated by a deep concavity. The gaster is broadly oval, hardly longer than broad, rounded above, on the sides and behind, without longitudinal ridges and with a distinct median longitudinal groove at the base.

29. *Iridomyrmex iniquus* Mayr. ☿.— Cinchona, 5,000 ft.
30. *Iridomyrmex iniquus* Mayr var. *nigellus* Forel. ☿.— Kingston.
31. *Prenolepis* (*Nylanderia*) *longicornis* Latr. ☿ ♀.—Newton, 3,000 ft.
32. *Prenolepis* (*Nylanderia*) *vividula* Nyl. ☿.— Cinchona. 5,000 ft.
33. *Brachymyrmex heeri* Forel var. *obscurior* Forel. ☿ ♀ ♂.— Cinchona, 5,000 ft.
34. *Camponotus* (*Myrmoturba*) *conspicuus* F. Smith.

Worker maxima. (Fig. 1, a). Length 8–10 mm.

Head rather small, trapezoidal, with broadly excised posterior border and the sides straight in the middle and rounded anteriorly. Cheeks with an oblique impression. Eyes moderately large, vertex with three ocellus-like pits. Mandibles small, very convex, 7-toothed. Clypeus sharply carinate, its lobe very short and indistinct, hardly notched in the middle. Frontal area small, rounded anteriorly and posteriorly. Antennal scapes slightly flattened but not dilated at the base, gradually enlarged distally and extending about $\frac{1}{3}$ their length beyond the occipital border of the head. Thorax narrow and low, laterally compressed behind, its dorsal outline in profile rather evenly convex, but with the base of the epinotum feebly concave. The base is twice as long as the declivity into which it passes through a distinct obtuse angle. Mesonotum present but bounded by feeble sutures; promesonotal suture strongly impressed. Petiole small, oval, as high as the epinotal angle, convex in front, flat behind, with entire, rounded, moderately sharp border. Gaster elongate elliptical. Legs slender, middle and hind tibiae slightly compressed, distinctly grooved, without a row of bristle on their flexor surfaces.

Shining; mandibles coarsely punctate, shagreened and subopaque at the base. Head subopaque, densely punctate in front, shagreened behind; clypeus and cheeks more shining, covered with sparse, elongate, shallow, piligerous foveolae. Thorax, petiole, gaster, and legs very finely shagreened and covered with small, sparse, piligerous punctures.

Hairs yellow, long, erect, and sparse on the body, shorter on the gula, longest on the gaster. Scapes with a few erect hairs at their tips. Legs and especially the tibiae with very short, stiff, oblique hairs. Cheeks and clypeus with a number of somewhat longer, suberect hairs. Pubescence yellow, rather long, dilute, very distinct on the gaster and corners of the head, almost lacking on the thorax, indistinct on the antennal scapes.

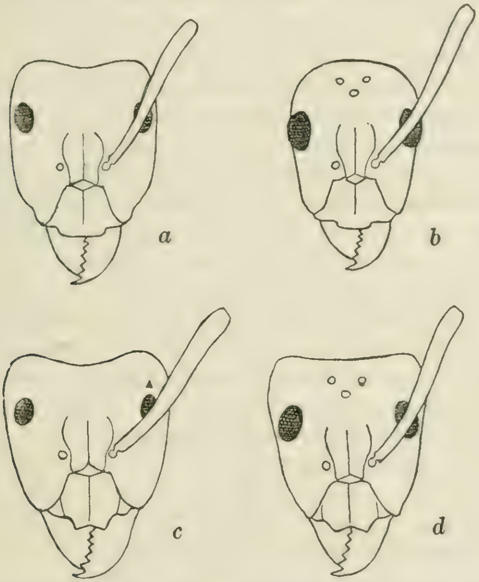

Fig. 1. *Camponotus (Myrmoturba) conspicuus* F. Smith, *a*, head of *worker maxima*, *b*, head of female, *c*, head of *worker maxima* of *C.* (*Myrmothrix*) *hannani* Forel, *d*, head of female.

Yellowish red; head a little darker, legs slightly paler; mandibles and antennae dark red, the former with black teeth; anterior border of clypeus and cheeks black. Gaster with an ill-defined brown band across the posterior portion of each segment.

Worker minima. Length 5–6 mm.

Head $1\frac{2}{5}$ times as long as broad, as broad through the anterior orbits as at the anterior border, constricted behind the eyes but with rounded sides to the occiput; the articular border short and nearly straight. Eyes rather large and convex, their anterior orbits at the middle of the head. Clypeus carinate, with broad, rather rounded anterior lobe. Antennae slender; scapes terete, extending half their length beyond the occipital border of the head. Thorax slender and low. Petiole and legs like those of the *maxima.*

Sculpture, pilosity, and color as in the *maxima* with the following exceptions:— head smooth and shining like the thorax and of the same color; scapes covered with very short subappressed hairs.

Female. (Fig. 1b). Length 10–12 mm.; wings 9 mm.

Head very narrow, nearly $1\frac{1}{3}$ times as long as broad, slightly broader behind than in front, with rather straight sides and occipital border. Clypeal lobe rectangular, longer than in the *maxima,* with straight, entire border. Eyes large and convex. Antennae like those of the *maxima* but shorter though extending half their length beyond the occipital border. Thorax long and narrow, regularly elliptical, somewhat broader than the head; mesonotum longer than broad; epinotum evenly rounded, without distinct base and declivity. Petiole like that of the *maxima,* its border entire. Gaster long and narrow.

Sculpture, color, and pilosity as in the *maxima,* the erect hairs on the thorax shorter. Wings pale yellow, with yellow veins and pterostigma.

Male. Length 5–6 mm.

Head, including the eyes, very nearly as broad as long, cheeks straight, slightly converging in front, occipital region broadly rounded. Mandibles small, slender, edentate. Clypeus distinctly carinate, with distinct, entire anterior lobe. Antennae slender, their scapes reaching nearly $\frac{2}{3}$ their length beyond the posterior border of the head. Eyes and ocelli large and prominent. Thorax broader than the head, mesonotum as broad as long. Epinotum convex, sloping, without distinct base and declivity. Petiole thick and low, higher behind than in front, its dorsal surface flattened, subrectangular when seen from above, nearly twice as broad as long and a little broader behind than in front. Gaster, genital appendages, and legs slender.

Smooth and shining, ocellar region and in some specimens the mesonotum more opaque.

Pilosity and pubescence similar to those of the worker, but antennal scapes nude and tibiae with delicate oblique hairs.

Color entirely yellowish red in some specimens, in others yellowish brown, with the occipital portion of the head and segmental bands on the gaster dark brown, the disc of the scutellum and three vague bands on the mesonotum pale brown. Wings colored like those of the female.

Described from numerous specimens of all four phases from Liguanea Plain (Brues), Montego Bay (Amer. Mus. Coll.), Kingston (Forel), and Port Henderson (Paulmier).

It seemed advisable to describe this ant in detail as it has never been adequately described and as its taxonomic status seems to be doubtful. Its identification has been accepted on Forel's authority, but when we turn to Smith's brief description of *Formica conspicua*, based on a female specimen from Jamaica, it is by no means certain that Forel's interpretation is correct. Smith says that his specimen measures 5–5.5 lines and is "chestnut red; the head about the same width as the thorax, slightly excavated behind; the clypeus subcarinate in the middle, its anterior margin slightly but widely emarginate; mandibles strong, punctured and armed with four or five teeth." The petiolar scale is "wide, ovate, with the margin entire." Now several points in this description, such as the size, strong mandibles, and the shape of the clypeus fit the female of *C. hannani* Forel much better than the form he identified as *conspicuus*, although this is not true of the petiole. Mayr, who in 1884 examined Smith's type in the British Museum, says only that it is "ein Camponotus mit abstehend behaarten Tibien." This would also agree with the long tibial pilosity of *hannani*, especially as he would hardly single out the very short tibial hairs of Forel's *conspicuus* as a noteworthy character. It seems probable, therefore, that Forel's *hannani* is a synonym of Smith's *conspicuus* and that Forel's *conspicuus* should be renamed, but as this can be decided only by comparison of both species with Smith's type, I accept Forel's interpretation provisionally.

*35. *Camponotus* (*Myrmoturba*) *maculatus* Fabr. subsp., *jamaicensis*, subsp. nov.

Worker maxima. (Fig. 2 *a*, *c*). Length 7.5–8.5 mm.

Head large, trapezoidal, longer than broad, with rather straight sides and broadly excavated occipital border. Eyes small, feebly convex. Mandibles 5–6 toothed. Clypeus strongly carinate, its anterior lobe rather well-developed, rounded on the sides and feebly and narrowly emarginate in the middle. Antennae slender, scapes not compressed, surpassing the posterior corners of the head by about $\frac{1}{5}$ their length. Thorax slender, in profile rather low and long, compressed posteriorly, the dorsal surface evenly convex, the base of the epinotum nearly twice as long as the declivity into which it passes through a distinct angle. Petiole small and narrow, higher than broad, with convex anterior and flat posterior surface, the border moderately sharp, rounded on the sides, slightly truncated in the middle above or even somewhat conical. Gaster rather small and narrow. Legs slender; tibiae neither compressed nor grooved, the posterior pairs without a series of bristles on their flexor surfaces.

Mandibles shining, coarsely and somewhat densely punctate, substriate near the base. Head opaque, with only the anterior corners shining, densely punctate, with the sides, posterior corners and the clypeus evenly covered with scattered, shallow piligerous punctures. Thorax and petiole opaque, more finely and densely punctate than the head. Gaster rather shining, finely, transversely shagreened and with sparse piligerous punctures.

Hairs fulvous, erect, rather long and abundant on the dorsal and gular surfaces of the head, thoracic dorsum, petiolar border, and gaster. On the vertex and sides of the head, epinotum and upper surface of the gaster there are also short, sparse, appressed hairs, representing a very coarse, sparse pubescence. Antennal scapes with denser and finer, subappressed hairs or pubescence. Legs covered with similar but longer and stiffer hairs especially conspicuous on the tibiae.

Mandibles dark red with black teeth and bases or black throughout; head black, its posterior fifth often rich reddish brown. Thorax and gaster dark brown, the sutures of the former, posterior segmental borders of the latter and the petiole brownish yellow or yellowish brown. Antennal scapes and base of first funicular joint black, remainder of funiculus dull fulvous. Legs brownish yellow, the femora sometimes darker.

Worker minima. (Fig. 2 *b*). Length 4.5–5.5 mm.

Head about $\frac{1}{3}$ longer than broad, a little broader in front than at the level of the eyes, with straight sides and rounder, converging postocular borders. Mandibles with 6 subequal teeth. Clypeus sharply carinate, the anterior border rounded and entire, its edge indistinctly crenulate. Antennae slender; scapes reaching about half their length beyond the posterior border of the head. Thorax and petiole like those of the *maxima*.

Sculpture, pilosity, and color much as in the *maxima* but the head is entirely dark brown like the thorax and the hairs on the body and appendages are somewhat shorter.

Male. Length 5 mm.

Head small and narrow, a little broader behind than in front, rounded and convex behind with straight cheeks as long as the very convex eyes. Antennae slender. Epinotum evenly convex and sloping, without distinct base and declivity. Petiole thick, with very blunt, transverse, entire dorsal surface.

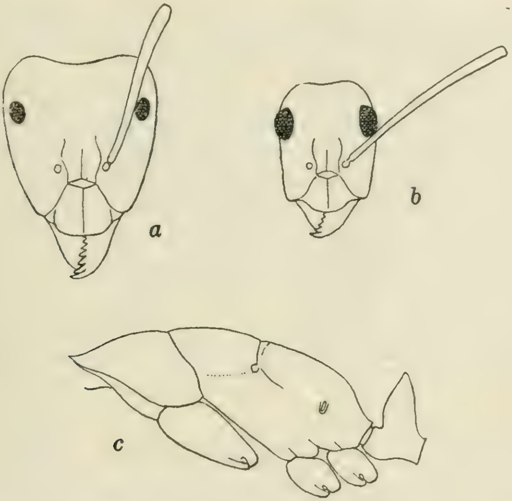

Fig. 2. *Camponotus* (*Myrmosaga*) *maculatus* Fabr. subsp. *jamaicensis* subsp. nov. *a*, head of *worker maxima*, *b*, head of *worker minima*, *c*, thorax and petiole of *worker maxima* in profile.

Head and thorax opaque, densely punctate. Petiole and gaster shining, shagreened.

Pilosity as in the worker; the long, erect hairs most abundant on the gaster.

Nearly black; antennal funiculi, mandibles, legs, sutures of thorax, tibiae, and tarsi brown, femora darker. Wings slightly tinged with brown anteriorly; veins and pterostigma pale brown.

Described from several specimens from Newton, 3,000 ft. (type locality); Liguanea Plain (Brues) and Mandeville (A. E. Wight).

This form approaches the subspecies *picipes* Olivier and especially its variety *pilosulus* Forel. In pilosity it is much like the typical *picipes* but is smaller and the surface of the body is more opaque and the head of the *maxima* has the sides more nearly straight. It resembles *pilosulus* in size but the latter is much more pilose and has the antennal scapes covered with suberect hairs, its head is shaped like that of *picipes* and the surface of the body is shining. In the male *jamaicensis* the head is shorter than in *picipes*, the petiole is entire above, the wings are tinged with brown, the legs are much paler and the body is less shining and not so black.

36. *Camponotus* (*Myrmothrix*) *hannani* Forel. (Fig. 1 *c* and *d*).
☿ ♀.— Newton, 3,000 ft.; Liguanea Plain.

The female measures 12.5 mm., its wings 14 mm. It closely resembles the *maxima* in color, sculpture, and pilosity but the head is smaller, with straight sides and nearly straight posterior border. The antennal scapes are narrower and less flattened, the upper border of the petiole is sharp and rather deeply notched in the middle and the posterior portion of each gastric segment is darker than the remaining surface. The thorax is elongate, elliptical, not broader than the head, the epinotal declivity is vertical and twice as long as the base. The mesonotum and scutellum are very smooth and shining, their erect hairs shorter than those of the worker. The wings are strongly tinged with yellow and the veins and pterostigma are resin-colored.

37. *Camponotus* (*Myrmobrachys*) *capperi* Forel. (Fig. 3, *a*).

Forel places this species in his subgenus Myrmothrix, but it seems to belong more properly in Myrmobrachys. In the typical *capperi* as I find from examination of two cotypes received from Professor Forel, the base of the epinotum is distinctly concave, with the epinotal angle pronounced, so that the thorax is much like that of many Malagasy and Australian species of Myrmosaga. The antennal scapes are naked, save for a few erect hairs at their tips, and the tibiae have short appressed hairs on their flexor surfaces.

*38. *Camponotus* (*Myrmobrachys*) *capperi* var. *formosulus*, var. nov.

Worker. (Fig. 3 *d*). Length 4.5–5.5 mm.

Differing from the typical form in the shape of the head, which is more elliptical in the larger workers, with more convex sides, in having the base of the epinotum perfectly straight and horizontal in profile, the petiole red like the gaster instead of black like the head and thorax, and each gastric segment with a more distinct fuscous band in front of the pale yellow posterior margin. The funiculi and femora are red, the tarsi, tibiae, and knees darker as in the typical form. There is little difference in pilosity, except that the gaster of the new variety has longer and more numerous erect hairs in addition to the long, dense pubescence.

Male. Length 4–4.5 mm.

Head through the eyes as broad as long, with straight, subparallel cheeks and semicircular postocular region. Mandibles edentate. Clypeus carinate, with entire, rounded and somewhat projecting anterior border. Thorax robust; mesonotum large and protuberant, overarching the pronotum, broader than long. Petiole short, thick and low, its dorsal surface impressed in the middle. Gaster rather broad.

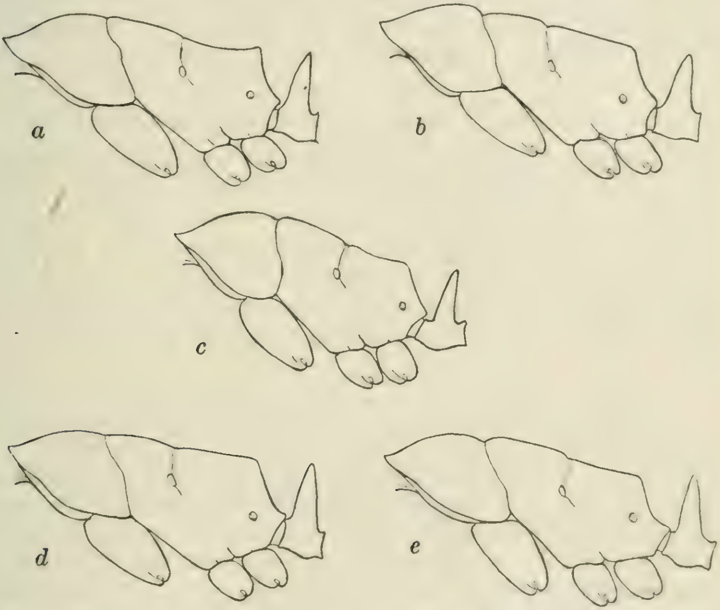

Fig. 3. *a, Camponotus* (*Myrmobrachys*) *capperi* Forel, thorax and petiole in profile; *b*, same of subsp. *corticalis* Forel, *c*, of subsp. *unctulus* subsp. nov., *d*, of var. *formosulus* var. nov., *e*, of subsp. *subdepilis* Wheeler.

Mandibles shining, punctate; head and thorax opaque, densely and finely punctate as in the worker; epinotum, petiole, and gaster very finely punctate-shagreened and shining.

Hairs pale, erect, very sparse on the head and thorax, more abundant on the gaster; pubescence yellowish, on the gaster much as in the worker, long and dense and nearly concealing the surface.

Black; mandibles, funiculi, legs, petiole, and gaster reddish brown; wings dull brownish hyaline, with brown veins and pterostigma.

Described from numerous specimens taken by Mr. A. E. Wight at Troy (type locality), Mandeville, and Balaclava. Those from Mandeville were attending membracid nymphs. In my 1911 list of Jamaican ants I referred this form to the typical *capperi*, but it undoubtedly represents a distinct variety or, perhaps, even a subspecies.

39. *Camponotus* (*Myrmobrachys*) *capperi* subsp. *corticalis* Forel.

In this subspecies (Fig. 3 *b*), of which I have examined three cotypes taken by Forel at Kingston, the thorax is like that of the var. *formosulus*, except that the mesoëpinotal suture is more deeply impressed. The color is different, the head, thorax, and gaster being black, the antennae, legs, and petiole red, the antennal scapes and tibiae have numerous suberect hairs and the pubescence on the gaster is much shorter and sparser so that the shining surface is clearly visible.

40. *Camponotus* (*Myrmobrachys*) *capperi* subsp. *subdepilis* Wheeler.

☿.— Port Antonio, Troy, and Balaclava (A. E. Wight).

This form (Fig. 3 *e*), described as a variety of *corticalis*, evidently deserves to rank as a subspecies. The head of the *major* worker is longer, more elliptical and with more convex occiput; the epinotum is shaped like that of the subsp. *corticalis*, but the mesoëpinotal suture is less impressed. The erect hairs on the body are much less numerous and lacking on the scapes and tibiae. The color and sculpture are similar, but the gaster is somewhat more shining and the petiole is darker.

*41. *Camponotus* (*Myrmobrachys*) *capperi* subsp. *unctulus*, subsp. nov.

Worker. (Fig. 3 *c*). Length 4.5–6 mm.

Head of the *maxima* much as in the typical *capperi*, subtrapezoidal, with the sides and posterior margin feebly convex. Thorax differing from that of all the preceding forms of *capperi* in being shorter, more convex anteriorly, with the epinotum lower and much more compressed laterally. Base of epinotum distinctly concave in profile as in the typical *capperi*, and the promesonotal suture deeply, the meso-ëpinotal suture not impressed. The petiole is also thinner.

Sculpture, color, and pilosity much as in *subdepilis*, but the head and thorax are less opaque, the promesonotal suture very shining and the petiole black like the head, thorax, and gaster.

Female (deälated). Length 8 mm.

Long and slender. Head subopaque and densely and finely punctate, clypeus and cheeks with scattered, shallow piligerous foveolae, thorax and gaster shining, mesonotum with a few coarse punctures or foveolae. Petiole with the upper margin notched in the middle. Pilosity and pubescence even sparser than in the worker, the pubescence on the gaster very short. Black; clypeus, cheeks, antennae, legs, pro- and mesosterna red.

Described from a single female and 44 workers belonging to a single colony taken by Professor Brues at Newton, 3,000 ft.

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EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Carton nest of *Crematogaster brevispinosa* Mayr subsp. *vicina* Ern. André. About $\frac{2}{5}$ natural size.

Photograph by Prof. C. T. Brues.

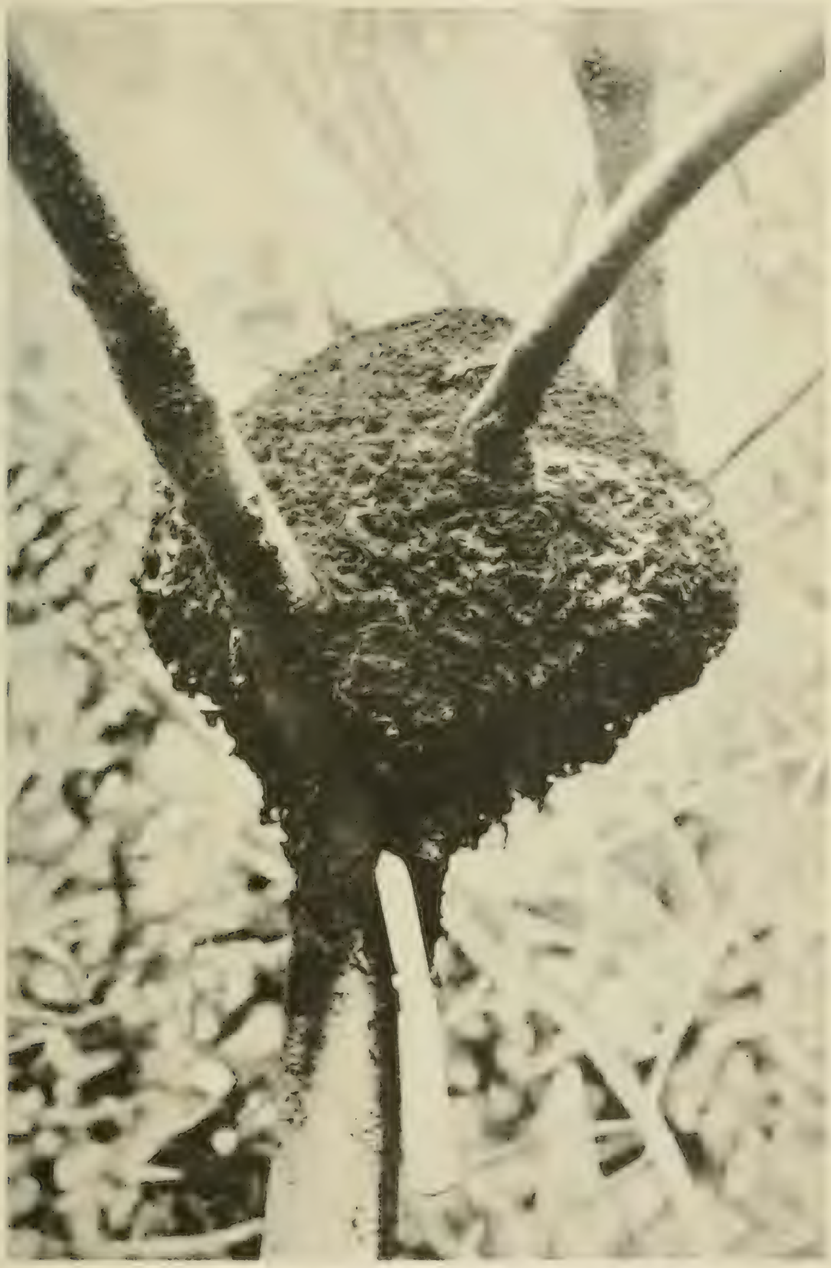
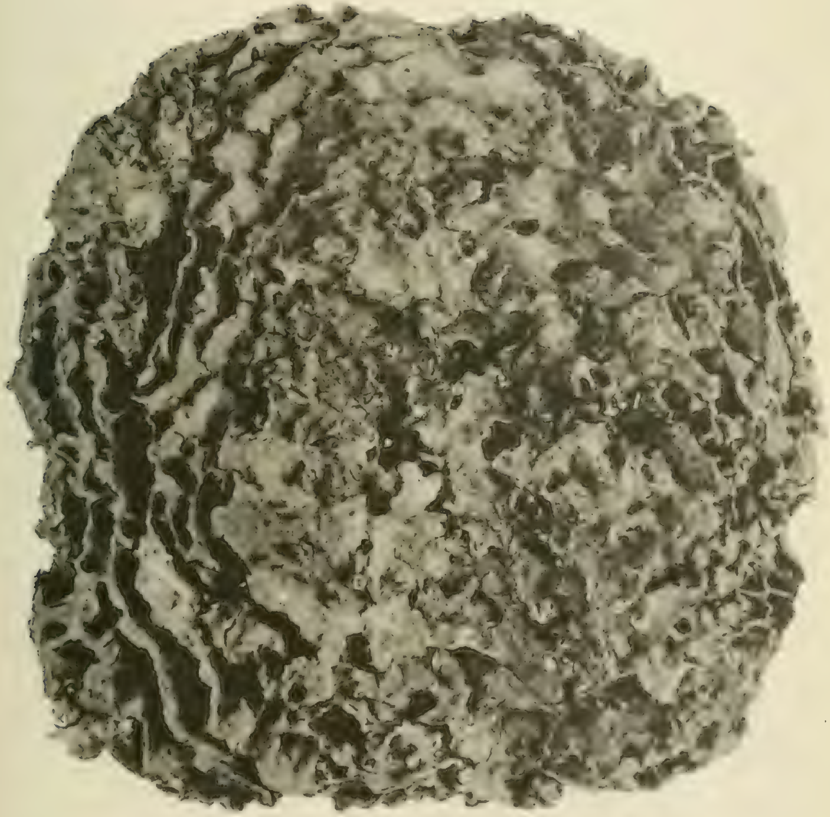


PLATE 2.

PLATE 2.

Carton nest of *Crematogaster brevispinosa* Mayr subsp. *vicina* Ern. André. Natural size, in section.

Photograph by Prof. C. T. Brues.



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AT HARVARD COLLEGE.
Vol. LXI. No. 14.

VERTEBRATA FROM MADAGASCAR.

INTRODUCTION.

By George R. Agassiz.

AMPHIBIA; REPTILIA.

By Thomas Barbour.

AVES.

By Outram Bangs.

MAMMALIA.

By Glover M. Allen.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.
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No. 14.—*Vertebrata from Madagascar.*

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1.—INTRODUCTION. By GEORGE R. AGASSIZ.

THE Museum was fortunate in securing, through the generous enthusiasm of Mr. Frederick R. Wulsin, the collection of Madagascar vertebrates described in the following pages. Mr. Wulsin spent four months, June – September, 1915, in Madagascar and this summary of his travels is taken from his journal. On completing a collecting expedition in East Africa, he sailed from Mombasa on the Messageries Maritimes steamer EL KANTARA, taking with him three Swahilis, besides his camp equipment, collecting guns, and ammunition.

On June 1, the steamer reached Tamatave, the chief port of Madagascar, somewhat more than half-way up the east coast. The town, crowded on a sandspit, which projects at right angles to the general coast line, has a population of about forty-six hundred, and owes its importance to a commodious harbor formed by a coral-reef. Here he found that a circular letter from the Governor General, written at the request of the Ministre des Colonies, had opened all doors to him.

His first move was by rail to the Capital Tananarive, about 135 miles w.s.w. from Tamatave. The journey takes about fifteen hours, the train passing at first through a flat country of thorny scrub, broken here and there by glades, then winds up around sharp curves to reach the central plateau. This region has some second growth, but the views from the train disclosed no virgin forest, it was mostly grass-covered hills with rice fields and villages dotting the valleys.

Here, as at Tamatave, the country teems with comparatively civilized natives. The inhabitants of these parts, the Hovas, are the most advanced of all Malagasy tribes. They could be seen collected at the little stations, pleasant, intelligent looking people, with *café au* *lait* complexions, "European" clothes, bare feet, and lambas, big white cotton cloths wrapped around their shoulders.

Tananarive or Antananarivo, the "town of a thousand," has a population of about 80,000, and is built, at an elevation of some 4,500 feet, on the slopes of a long and narrow stony ridge, overlooking an extensive rice plain. The original town of wooden palaces and rush houses, has been largely rebuilt, since the introduction of brick and stone, about 1870. Here Mr. Wulsin spent several days buying supplies, and completing arrangements for his expedition.

The first stage of his collecting explorations led him across the island to Morondava, about two thirds of the way down the west coast. The journey began with a day's automobile trip of 170 kilometres to the little town of Antsirabe, which proved to be a pleasant European looking place, with an inn, several shops, and a small colony of agreeable Europeans. Here he hired twenty-eight porters, eight of whom carried a hammock, and marched seven days to Miandrivazo, on the Mahajile River, a branch of the Tsiribihina, which empties on the west coast, some hundred kilometres to the north of Morondava. The town where he now found himself consists of rectangular, whitewashed, adobe houses, about twelve by twenty feet, with dirt floors and small windows without glass. The grass-thatched roofs and overhanging verandas, while they give the town a picturesque appearance, do not dispel the impression that the place is capable of much improvement by a little effort, which the natives are too lazy to make. This collection of native villages which constitutes the town, is a government-post and post-office. The officials who constitute most of the white population live in well-built adobe houses with board floors, and form a colony whose life resembles that of a small provincial French town. For some days Mr. Wulsin made Miandrivazo his headquarters for collecting; his Swahili boys being indefatigable in that work.

He next proceeded down the river, with a flotilla of six narrow dugouts lashed together in pairs. The first day and a half was through country similar to that about Miandrivazo, a broad valley full of ponds and marshes, studded with banana groves and rice fields, and flanked on each side by sharp low hills. Then the country changed to a narrow valley with steep hills wooded to the water's edge; and culminated in Les Gorges des Bemena. The party spent two days collecting in this neighborhood, getting twenty-five Lemurs in the general bag.

Once out of the Gorge the canoes drifted down a winding, tranquil river, and stopped at the little village of Begidro. Here with the aid of the native inhabitants there was an organized hunt for a wild pig for the Museum, and incidentally for wild cattle for meat. The result was one cow. Mr. Wulsin formed but a poor opinion of the efficiency and ability of the natives of this immediate neighborhood. Indeed one would judge that their imperfect contact with civilization had resulted in producing specimens of humanity as nearly helpless as the Fuegian, whom Darwin returned to his native heath.

Continuing down stream, the expedition reached the Government post of Berevo, on the Tsiribihina. Here Mr. Wulsin hired porters and left the river. These porters were able to carry little, for it took twenty-four men to carry what would have made twelve or thirteen loads in East Africa. The Madagascan natives are said, however, to be remarkable walkers, a good hammock crew is supposed to be capable of from 80 to 110 kilometres a day, for several days in succession. The Sakalava, the natives of this western watershed of the island, are in general a big, well-built, good-looking people, not so black as a negro, but dark chocolate, with features far nearer to our ideas of beauty than those of the African. Both sexes do up their black, crinkly hair in big loose balls. The men generally have pointed beards and thin mustaches. The basic costume of the men is a loin-cloth, and a sort of cloth-skirt. The women wear a graceful costume which consists of a cloth wound around and hanging down from just below the arms. This they keep in place with a solicitude not in keeping with their poor reputation for virtue. The Sakalava, pure and undefiled, is a savage. The Hova, is not seen pure and undefiled, for white influence among them is old, and it is from the white man that they have learned their present methods of life. Some of their women are not only pretty but well-mannered and well-bred. Mr. Wulsin considers them as far ahead of the Sakalava as the white man is ahead of the Hova.

The country to the southwest of Berevo was found to consist chiefly of patches of forest, looking to the uninitiated like those of the Adirondacks without evergreens. Interspersed with these forest patches were stretches of open, rolling, stony ground, covered with long, coarse, dry grass. A march of several days brought the party to the Morondava River, at a point some two days' canoe-trip above the town of that name.

After some days spent in collecting in the neighborhood of Morondava, Mr. Wulsin went by steamer with his Swahilis to Tulear, about three degrees further south. Tulear is somewhat larger than Morondava, with a big busy market. It boasts of three or four general stores run by white men, a hardware store, a lot of little Hindu shops, a branch of the Comptoir d'Escompte, a Messageries office, a garrison, a Government hospital, and Government offices; but with it all, a slack and sleepy town. Collecting here revealed a suburb of villas of colonists, with gardens and hedges bordering roads on which was much traffic. It was not till some three miles out of the town that the well-kept farms gave place to the open country, and native villages and plantations.

On August 4th, Mr. Wulsin left Tulear by sea-canoe, large, able, built-up dugouts, with high freeboard and great capacity. The journey southward was along a desolate, sparsely inhabited coast. The natives with their hair done up in rolls smeared with ox-fat, had rounder faces and were more snub-nosed than the Sakalava. But on the whole they were as good-looking and had as comfortable houses as most of the western natives, outside the big centres. Owing to a head-wind the party did not reach their objective, Lake Tsimanampetsotsa, till the 8th. The Lake is a long, narrow, brackish, shallow sheet of water, on a mud-flat not far from the sea-coast. Here Mr. Wulsin was not successful in collecting water-fowl, as he was unable to get within range of the birds on the Lake, although shooting many in the country round about. The natives declared there were fish in the Lake, but that they were unable to catch them.

On his return to Tulear, Mr. Wulsin, after a few days collecting, steamed up the west coast in the BAGDAD, and disembarked at Majunga, the seaport of the northwest province of Majunga, a town somewhat smaller than Tamatave. From here he proceeded by small steamer and launch up the Betsiboka River to Maevatanana. This is a provincial headquarters, well laid out with shaded roads and good buildings. Here Hova influence was again evident; showing itself in the comfortable two-story brick houses, that have replaced the native dwellings, in the well-dressed women in European costume, and in the men clad in trousers and shirts.

Two days by the weekly automobile service, through the eternal "Mammelon" or hillocky country of the central plateau, brought Mr. Wulsin back to Tananarive.

His last expedition on the island was to Lake Alaotra, some distance to the north. A branch railroad from Moramanga, on the line to Tamatave, runs to Andaingo, some forty miles south of the Lake. Here he slept in an empty freight car, by way of hotel accommodation. The population on the way to the Lake was a great contrast to that of the Sakalava districts. The neat little villages, composed mostly of reed-houses, had occasional two-story houses, some of brick. The inhabitants, docile, cheerful, and good-tempered, keep little shops, wear straw hats, and are far from being savages.

While the Swahilis collected water-birds on the south shore of the lake, Mr. Wulsin devoted two days to shooting crocodiles, on the Sahabe River, which flows into the Lake from the south. After a few days spent a little further south, on the edge of the Eastern Forest, at the little town of Didy, the party returned to Tananarive. Then having packed his collections, Mr. Wulsin sailed from Tamatave for Europe, the latter part of October, leaving his Swahilis on the way at Mombasa.

2.— Amphibia and Reptilia. By Thomas Barbour.

The Wulsin series of amphibians and reptiles supplement very satisfactorily the Madagascan material already in the Museum of Comparative Zoölogy. This consisted of a quantity of examples collected by Voeltzkow and received in exchange through the late Oskar Boettger. That exchange containing an excellent series of such an interesting form as *Voeltzkovia mira*, was our greatest previous acquisition from the Mascarene region. Early missionaries and New England sailing masters had also contributed considerable material from Nosy-Be and from other of the more oft visited ports. From among these specimens Cope described *Tomosterna labrosa*, really one of only two species of Rana known from Madagascar and one long confused with *Rana natalensis* Smith.

A far larger number of species of reptiles than of amphibians were secured by Mr. Wulsin; a fact in part due to the rather more specialized knowledge necessary to secure the latter, the dry weather encountered, and the added circumstance that much of the collecting was in the arid almost semidesert southwestern district about Tulear.

A number of species of Amphibia are omitted for the reason that it is desirable to have them compared with authentic European material, something not now practicable.

Mr. Wulsin obtained while in Madagascar a very considerable collection which had been made in the great Eastern Forest at a point about half way between Tamatave and Tananarive and "Eastern Forest" is used as a locality-record for this collection, which provides the only new reptiles obtained. This fact emphasizes the truth of Voeltzkow's words "Es steht wohl ausser zweifel, dass mit obiger ziffer die zahl der auf Madagascar vorkommenden Reptilien — und Amphibienarten noch bei weitem nicht erschöpft ist"; he then recommends for further collecting activity:— "den noch wenig erforschten feuchten Urwäldern des hohen Steilabsturzes der Ostküste". (Reise in Ostafrika, 1913, **3**, p. 374).

AMPHIBIA.

RANIDAE.

1. RANA MASCARIENSIS Duméril & Bibron.

Found abundantly almost everywhere. Several hundred specimens were secured and almost as many preserved. The same frog also occurs widely spread in Africa.

2. MANTIDACTYLUS GUTTULATUS (Boulenger).

Two fine adults, a male and a female, from the Eastern Forest.

3. MANTIDACTYLUS MADAGASCARIENSIS (A. Duméril).

A single beautiful specimen from the Eastern Forest.

REPTILIA.

GEKKONIDAE.

1. PHYLLODACTYLUS PICTUS (Peters).

I concluded at first that a fine adult from Begidro on the Siribihina River represented *Diplodactylus robustus* Boulenger (Ann. mag. nat. hist., 1896, ser. 6, **17**, p. 444), but it does not quite agree with the description in color nor in the arrangement of the labials. Mocquard has placed Boulenger's name in the synonymy and Boettger evidently accepts this allocation since the name does not appear in his Check list (Reise in Ostafrika, 1913, **3**, p. 370). Dr. Boulenger has written me that he has had no opportunity to verify Mocquard's statement and that until the types are really compared there must remain some doubt as to the identity of these two forms. Mocquard adds *oripes* Boettger to the synonymy, but this species is considered valid by Boettger (mis-spelled *oviceps*) (*loc. cit.*, p. 327).

2. PHYLLODACTYLUS BASTARDI Mocquard.

Wulsin secured a fine adult at Miandrivazo on June 26, 1915. It agrees perfectly with Mocquard's detailed description (Bull. Soc. philom., 1900, ser. 9, **2**, p. 101).

3. EBENAVIA INUNGUIS Boettger.

Boettger in his Check list of Madagascan reptiles, (Reise in Ost-Africa., 1913, 3, 4, p. 368–373), recognizes but a single species in this genus. Previously to noticing this I had identified four examples from the Eastern Forest as *Ebenavia boettgeri* Boulenger. These four specimens vary a good deal *inter se* and I have no doubt but Boettger following Mocquard (Nouv. archiv. Mus. hist. nat. Paris, 1909, ser. 5, **1**, p. 15) was correct in considering the genus monotypic.

4. MICROSCALABOTES COWANI Boulenger.

One from the Eastern Forest and two from Tulear in southwestern Madagascar. The two latter examples seem to have shorter toes than the former and may represent a valid race. The genus does not seem to have been taken previously in the Tulear area.

5. BLAESODACTYLUS BOIVINI (A. Duméril).

One beautifully preserved example from the Eastern Forest.

6. Geckolepis maculata Peters.

Three examples which I identify provisionally were in the series from the Eastern Forest. This and several other genera in the collection are probably not represented in any other American museum; there were no Geckolepes in the British Museum when the Catalogue was published in 1885, and for this reason as well as the fact that some of the descriptions are meagre and many based upon rather scanty material make one far from certain of the status of some of the species described.

7. Hemidactylus mabouia (Moreau).

Six examples from the Eastern Forest. The Museum already had several species of this circumtropical species from various points in Madagascar.

8. Phelsuma lineatum Gray.

Three beautiful specimens from the Eastern Forest.

9. Phelsuma laticauda (Boettger).

A fine series taken during September, 1915, in the swamps near Didy.

10. Phelsuma cepedianum (Merrem).

Two specimens from the Eastern Forest differ a good deal in coloration from Mauritius examples. The genus Phelsuma badly needs revising with adequate material. The Museum had previously received from Boettger *P. madagascariense* Gray and *P. quadriocellatum* Peters. The latter considered by both Boulenger and Mocquard as but a variety of *P. laticauda.* Boettger in his Voeltzkow report does not speak of it at all. It would be interesting to know whether the peculiar markings are in any way correlated with habitat or locality.

Uroplatidae.

11. Uroplates fimbriatus (Schneider).

A fine adult from the Eastern Forest.

IGUANIDAE.

12. HOPLURUS SEBAE Fitzinger.

Of this species, perhaps the best known of its genus, there are two examples from Miandrivazo, taken in June 1915.

13. HOPLURUS CYCLURUS (Merrem).

A well-preserved adult from 20 kilometers northeast of Tulear, and another from Tulear itself. In the first mentioned example the anterior border of the ear is beset with three blunt scales forming a sort of coarse denticulation. The posterior aspects of the spinous caudals have hardly any trace of the serrations spoken of by Boulenger. There is a conspicuous dark collar across the hinder nape and a faint light middorsal line, otherwise the back is uniform slate color with a few scattered light spots.

14. HOPLURUS FIERINENSIS Grandidier.

Two examples from the Eastern Forest. Compared with the specimens of *H. grandidieri* Mocquard received from the Senckenbergian Museum these examples seem to be typical, for they differ from *H. grandidieri* in just the characters used in the separation (Bull. Soc. philom., 1900, ser. 9, **2**, p. 105).

15. CHALARODON MADAGASCARIENSIS Peters.

An enormous series from the semidesert country about Tulear, taken in August. Beyond various slight variations in color the series is remarkably uniform in scale-characters. This fine suite was especially welcome since this monotypic genus is confined to the little-visited southern district of Madagascar and is represented in but few museums.

GERRHOSAURIDAE.

16. ZONOSAURUS ORNATUS (Gray).

Two examples from the Eastern Forest, between Tamatave and Tananarive seem to be quite typical.

17. TRACHYLOPTYCHUS MADAGASCARIENSIS Peters.

Four from Tulear. These lizards represent another of the rare local forms met with only about Tulear and the southwestern desert region.

SCINCIDAE.

18. MABUYA ELEGANS (Peters).

Two from Tulear and one from the Eastern Forest.

19. MABUYA GRAVENHORSTI (Duméril & Bibron).

This common species is represented by six adults from the Eastern Forest and two from the swamps at Didy. The Museum has had it previously from several other localities and it is widely distributed over the island.

20. SCELOTES BRUNNEUS, sp. nov.

Plate **2**, fig. 1, 2.

Type.— M. C. Z. 11,870. Tanandra River, two days journey west of Tamatave, Madagascar. F. R. Wulsin.

Related to *S astrolabi* Duméril & Bibron, but differing in having 36 not 34 scales about the body, and in having the postnasal so small that it is reduced to a simple ring, which, however, permits the loreal to separate the supranasal and the first supralabial. Uniform rich brown above, yellowish below.

21. SEPSINA GASTROSTICTA (O'Shaughnessy).

A single specimen from the Eastern Forest.

22. SEPSINA MELANURA (Günther).

One from the Eastern Forest and two from the swamps near Didy.

23. Sepsina vulsini, sp. nov.

Plate **2**, fig. 3, 4.

Type.— M. C. Z. 11,869. Eastern Forest between Tamatave and Tananarive, Madagascar. F. R. Wulsin.

In general similar to *S. ornaticeps* Boulenger (Ann. mag. nat. hist., 1896, ser. 6, **17**, p. 448) scales 22 around body, but ear-opening much larger than nostril, supranasal well-separated from labials by postnasal. In *S. ornaticeps* the forelimb is only three sevenths of the distance from forelimb to tip of snout while in *S. vulsini* it is considerably more than half. The coloration is strikingly different, being rich brown above, each scale outlined with darker, the sides with a heavy dark, almost black, band light edged above. Lower sides and throat finely punctate with black, belly yellowish, tail mottled grey and brown, the sides of the tail darker than the upper or lower surfaces.

24. Pygomeles braconnieri Grandidier.

A single example from Tulear. The species is, so far as known, confined to southwestern Madagascar.

Chamaeleontidae.

25. Chamaeleo nasutus Duméril & Bibron.

One from the Eastern Forest.

26. Chamaeleo fallax Mocquard.

One from the swamps near Didy.

27. Chamaeleo brevicornis Günther.

Two adults from the swamps near Didy.

28. Chamaeleo pardalis Cuvier.

An excellent suite of various ages from the Eastern Forest.

29. CHAMAELEO OUSTALETI Mocquard.

Nine specimens from Morondava, one from Tulear and one from 10 kilometers northeast of Tulear. This series likewise is valuable in that various ages are represented.

30. CHAMAELEO LATERALIS Gray.

A single individual from Morondava taken in July, 1915.

31. CHAMAELEO CAMPANI Grandidier.

A large and well-preserved series from the Eastern Forest.

BOIDAE.

32. CONSTRICTOR DUMERILI (Jan).

An excellent adult from Morondava.

33. CORALLUS MADAGASCARIENSIS (Duméril & Bibron).

Seven adults from the Eastern Forest.

COLUBRIDAE.

34. POLYODONTOPHIS TORQUATUS (Boulenger).

One specimen from the swamps near Didy. This example is slightly aberrant in having no marking on the hinder part of the head.

35. DROMICODRYAS BERNIERI (Duméril & Bibron).

An adult from Morondava, also one young and one half-grown specimen from Tulear.

36. NATRIX STUMPFFI (Boettger).

Six adults from the Eastern Forest, and four from Didy.

37. NATRIX LATERALIS (Duméril & Bibron).

A considerable series from the Eastern Forest and two from the swamps near Didy.

38. NATRIX SEXLINEATUS (Günther).

Eight examples of this rare species from the Eastern Forest. Boettger includes this species and *N. grandidieri* both in *N. dolichocercus*. Boulenger, however, has shown (P. Z. S., 1915, p. 373) that in this he was entirely wrong.

39. LIOHETERODON MADAGASCARIENSIS (Duméril & Bibron).

A fine series from Morondava, Didy, and the Eastern Forest.

40. LIOHETERODON MODESTUS (Günther).

Three examples from the Eastern Forest. Boulenger (P. Z. S., 1915, p. 376) says that in this species the internasals are in contact with the frontal. In 1893, however, he figured the opposite, *i. e.* prefrontals separating the internasals from the frontal (Cat. snakes Brit. mus., 1893, **1**, pl. 18, fig. 1). Among these specimens two agree with the figure, while the third, evidently injured on top of the head, has the prefrontals barely touching the frontals and the internasals just separated.

41. PSEUDOXYRHOPUS QUINQUELINEATUS (Günther).

A single typical example from Didy, eastern Madagascar.

42. ETEIRODIPSAS COLUBRINA (Schlegel).

Fifteen from the Eastern Forest and two from the swamp at Didy.

43. MIMOPHIS MAHFALENSIS (Grandidier).

Nine from the Eastern Forest and one from 14 kilometers south of Miandrivazo.

CROCODILIDAE.

44. CROCODILUS NILOTICUS Laurenti.

Mr. Wulsin secured five adult crocodiles and two young. These are from the Morondava River, from Miandrivazo on the Tsiribihina River and from the Sahabe River just at the southern end of Lake Alaotra, — the latter the supposed locality of living *Crocodilus robustus* Vaillant and Grandidier. From all that Mr. Wulsin could learn from the naturalists connected with the Academy Malagache at Tananarive the specimens upon which the record of *Crocodilus robustus* as an existing species was based were simply very old males of *C. niloticus* from Lake Alaotra, a locality everywhere celebrated for the great abundance and enormous size of its crocodiles. There seems to be no doubt but that the individuals in this Lake reach a larger size than they do elsewhere in Madagascar, or probably anywhere in Africa as well. Boettger has relegated the names *robustus* and *madagascariensis* both to the synonymy of *niloticus*. In this I follow him regarding *madagascariensis*. But *C. robustus* Vaillant and Grandidier, as a rather recent fossil, is a valid species and a fine cranium from Antsirabe is figured (Plate **1**).

When the type of *C. robustus* was first found at Amboulintsatre it was associated with remains of Aepyornis and Hippopotamus and by an interesting coincidence Mr. Wulsin's collection contained the femur of Aepyornis and a beautiful skull, complete, of Hippopotamus. Thus it is only as a living form that we may consider *C. robustus* as synonymous with *C. niloticus*. The name must stand for the valid fossil species. (For the supposed record for living *C. robustus cf.* Vaillant, Compt. rend., 1883, **97**, p. 1081).

TESTUDINIDAE.

45. TESTUDO RADIATA Shaw.

Two shells secured at Tamatave.

CHELONIDAE.

46. CHELONIA VIRGATA Schweigger.

One stuffed specimen from Tulear. Pending the accumulation of sufficient material to attempt a critical study of the green turtles I am using Schweigger's name provisionally for the Indian Ocean specimens.

47. ERETMOCHELYS SQUAMATA (Girard).

One stuffed example also from Tulear. In using this name I follow Stejneger (Bull. 58, U. S. N. M., 1907, p. 511).

PELOMEDUSIDAE.

48. STERNOTHAERUS NIGRICANS CASTANEUS (Shaw).

A single adult, provisionally identified with this race, from Miandrivazo on the Tsiribihina River, western central Madagascar.

3.— AVES. By OUTRAM BANGS.

The collection of birds made by Mr. F. R. Wulsin, and his assistants, numbers 1,065 skins, belonging to 122 species and subspecies, four of which are described as new. The species are arranged in the sequence of Sharpe's Hand list of the genera and species of birds.

No field-work was done in the eastern parts of the island, but a small series of skins from the Eastern Forest was bought of a local collector. This series includes twelve species, namely: — *Sarothrura insularis* Sharpe, *Atelornis squamigera* (Lafresnaye), *Corapitta pittoides* (Lafresnaye), *Cuculus rochii* Hartlaub, *Coua caerulea* (Linné), *Philepitta castanea* (Müller), *Tylas eduardi* Hartlaub, *Mystacornis crossleyi* Grandidier, *Nesobates madagascariensis* (Gmelin), *Vanga rufa* (Gmelin), *Nelicurvius nelicourvi* (Scopoli), and *Hartlaubius auratus* (Müller).

I am greatly indebted to Dr. C. W. Richmond, Assistant Curator of Birds, U. S. N. M., who most kindly compared the series of skins of several species with the ample African material now in Washington, and answered a number of questions relating to synonymy and nomenclature.

PHASIANIDAE.

1. MARGAROPERDIX MADAGASCARIENSIS (Scopoli).

One adult ♂ forty-five miles south of Berevo, July 15.

NUMIDIDAE.

2. NUMIDA MITRATA Pallas.

Two males, one young, one adult, forty miles east of Miandrivazo, June 18, and Upper Siribihina River, July 4.

TURNICIDAE.

3. TURNIX NIGRICOLLIS (Gmelin).

Six adults, both sexes, Morondava, Berevo, and Lake Tsimanampetsotsa, July and August.

PTEROCLIDIDAE.

4. PTEROCLIS PERSONATUS Gould.

Nine specimens, adults of both sexes, twenty kilometers northeast of Tulear, Morondava River, and forty-five miles and thirty miles south of Berevo, July, and August.

TRERONIDAE.

5. VINAGO AUSTRALIS (Linné).

Three adult females, Miandrivazo, June 23, Upper Siribihina River, July 6, and Maevatanana, September 9.

6. ALECTROENAS MADAGASCARIENSIS (Linné).

One adult ♀, Ambola, southwestern coast, August 7.

PERISTERIDAE.

7. HOMOPELIA PICTURATA (Temminck).

Nineteen adult specimens, both sexes, Lake Tsimanampetsota, Ambola, twenty kilometers northeast of Tulear, Mahabo, and Miandrivazo, June, and August.

8. OENA CAPENSIS ALIENA, subsp. nov.

Twenty-six specimens, adults of both sexes, Miandrivazo, Morondava, Morondava River, Mahabo, Tulear, and Lake Tsimanampetsotsa, June, July, and August.

Type.— Adult ♂ M. C. Z. 77,895 Tulear, Madagascar, August 3, 1915. F. R. Wulsin.

Characters.— Similar to *Oena capensis capensis* (Linné) of South Africa and *Oc. capensis anonyma* Oberholser of British East Africa, but wing and tail averaging slightly longer; scapularis, mantle, and lower rump considerably darker; grey of head extended down to (or almost to) the mantle (in African birds the hind neck and nape are brown); the black bands bordering the white one on rump stronger (more apparent) and blacker; rufous on outer web of outermost primary less extensive.

Measurements, adult ♂, wing, 105–110, (107.08)[1]; tail, 130–143, (135.09).[2] Adult ♀, wing, 100–106, (103.06)[3]; tail, 125–135 (129.01).[4]

RALLIDAE.

9. RALLUS CUVIERI Pucher.

Five specimens adults of both sexes, Maevatanana, Miandrivazo, Upper Siribihina River, Ambatondrazaka, June, July, and September.

10. GALLINULA CHLOROPUS PYRRHORHOA Newton.

Fourteen specimens, adults of both sexes and young, southern end of Lake Alaotra, Maevatanana, Berevo, Ambatondrazaka, Miandrivazo, and Tulear, June, July, and September.

Every skin in this series, even of young birds, has the light portions of the under tail-coverts buffy or ruddy, but a close examination shows that the basal part of the feathers is pure white where the exposed ends are buff.

11. FULICA CRISTATA Gmelin.

Twelve adults both sexes, all taken at the southern end of Lake Alaotra, September 25.

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[1] Thirteen specimens.

[2] Eleven specimens.

[3] Eight specimens.

[4] Eight specimens.

COLYMBIDAE.

12. PODICEPS PELZELNI Hartlaub.

Five specimens, four adults in non-breeding plumage and one young in down, Sahabe River, Miandrivazo, and Mahabo, June, July, and September.

These skins have been carefully compared by Dr. Richmond with the series of *P. capensis* in the U. S. N. M. The four adults certainly are *P. pelzelni* which can be separated from *P. capensis* by the angle of the gonys being more lengthened, and the under mandible turning up rather less abruptly at the tip. There is also a tendency to a dusky spot near the tip of the outer secondaries in *P. pelzelni*.

LARIDAE.

13. HYDROCHELIDON LEUCOPAREIA DELALANDII Mathews.

Four adults, both sexes, all in winter plumage, southern end of Lake Alaotra, September 25.

I follow Mathews in recognizing a South African form, to which I refer our birds, not having sufficient material to decide the question as to the recognition of a subspecific form.

14. STERNA BENGALENSIS ARABICUS (Mathews).

One male (adult in winter plumage?) mouth of the Onilahy River, August 4.

In this instance, also, I simply follow Mathews.

15. LARUS DOMINICANUS Lichtenstein.

Two adult males, Ambola, southwest coast, August 7, and Nosy Asatra to Beheloka, August 6.

Mathews and Iredale, in their Reference list of the birds of New Zealand (Ibis, 1913, **10**, p. 248) use the name *Larus dominicanus antipodus* (Bruch) for the New Zealand bird without stating how it differs from the South American true *L. dominicanus*. I have carefully compared a number of specimens from each of the following localities: — southern South America, South Africa, and New Zealand and can find no tangible differences by which to separate them. I therefore consider them as belonging to one and the same subspecies.

CHARADRIIDAE.

16. MORINELLA INTERPRES INTERPRES (Linné).

Six specimens, both sexes, all taken from Nosy Asatra to Beheloka, August 6.

17. CHARADRIUS BIFRONTATUS Cabanis.

Four adults, both sexes, Maevatanana, and Berevo, Siribihina River, July 10, September 9, and 12.

18. CHARADRIUS MARGINATUS PALLIDUS Strickland.

Thirty-one specimens, Tulear, Maevatanana, Lake Tsimanampetsotsa, Beheloka, Upper Siribihina River, Morondava, St. Augustin Bay, and Nosy Asatra to Beheloka, July, August, and September.

It is possible that the Madagascan bird may prove separable from the African, in which case *tenellus* Hartlaub would be available.

19. CHARADRIUS VARIUS Vieillot.[1]

Eleven specimens, Maevatanana, Tulear, and Begidro, Upper Siribihina River, August, and September.

20. CHARADRIUS THORACICUS Richmond.

Six specimens, both sexes, three adults and three young, Lake Tsimanampetsotsa, and Nosy Asatra to Beheloka, August.

This is a fine species, the young birds, not quite full grown, have a blackish ring around the foreneck much as in the adults.

21. HYPSIBATES HIMANTOPUS MINOR Natterer.

Thirteen specimens, adults of both sexes, and one, two thirds grown, young, Miandrivazo, Maevatanana, southern end of Lake Alaotra, Mahabo, Morondava River, and Upper Siribihina River, June, July, and September.

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[1] Dr. C. W. Richmond cannot find that *varius* is preoccupied and advises its use instead of the later *pecuarius* of Temminck.

In the adults, irrespective of sex, the wing ranges from, 220–237 (226.63); the tarsus from 102–120 (112.4); the culmen from 60–62 (61.1). There is little doubt that females are smaller than males in this as in most, if not all the species and subspecies of Stilts. Some of the specimens unfortunately are almost certainly incorrectly labeled as to sex.

22. NUMENIUS ARQUATUS MADAGASCARIENSIS (Linné).

Two adult females, Morondava, July 22, and Ambola, August 7.

Van Oort (Notes from the Leyden museum, 1910, **32**, p. 116), has already pointed out that the Siberian Curlew winters in Madagascar, and must bear the above name. Our two specimens are distinctly referable to this form. Whether the differences are sufficiently great or sufficiently constant to warrant subspecific recognition must be decided when sufficient material is available.

23. NUMENIUS PHAEOPUS PHAEOPUS (Linné).

Two adults, one female, Tulear, August, one unsexed, without date.

One of these, a very bleached out specimen, is referable to the western Whimbrel, the other is apparently an intermediate and might be referred to either *N. phaeopus phaeopus* or *N. phaeopus variegatus* (Scopoli) with equal chance of accuracy.

24. CALIDRIS LEUCOPHAEA (Pallas).

Two females, in winter plumage, on an island at Nosy Asatra, southwestern coast, August 5, and Morondava, July 23.

25. EROLIA FERRUGINEA (Brünnich).

Forty-eight specimens, Tulear, August 18.

This series includes young of the year and adult birds with mottled rufous and white under parts, in about equal numbers.

26. ROSTRATULA BENGALENSIS MADAGASCARIENSIS (Boddaert).

Two specimens, ♂ and ♀, Maevatanana, September 9.

The Madagascan form of the Painted Snipe is probably a good subspecies. Our two specimens, compared with African birds, are darker and more greyish.

PARRIDAE.

27. PHYLLOPEZUS ALBINUCHA (Geoffroy St. Hilaire).

Fourteen specimens, both sexes, young and adults, Tulear, Berevo, Upper Siribihina River, Maevatanana, Miandrivazo, and southern end of Lake Alaotra, June, July, and September.

CURSORIIDAE.

28. GALACTOCHRYSEA OCULARIS (Verreaux).

One adult ♀, Maevatanana, September 11.

Family ?

29. MONIAS BENSCHI Oustalet and Grandidier.

Four adults, three males and a female, twenty kilometers northeast of Tulear, and Tulear, August.

Both the original describers and Hartert (Nov. zool., 1912, **19**, p. 373, pl. 1) suggest affinities to the Rallidae for this extraordinary species, whose systematic position is still unknown. The bird has powder-down patches somewhat different in detail, but on the whole not unlike those of Mesites.[1] Possibly the relationship of these two remarkable Madagascan types is not so very remote.

IBIDIDAE.

30. TRESKIORNIS BERNIERI Bonaparte.

Two adult males, thirty miles south of Berevo, July 14.

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[1] Dr. C. W. Richmond has some doubt as to the preoccupation of Mesites, but if preoccupied Mesitornis Bonaparte 1855, and not Mesoenas Reichenbach 1861 must be used.

31. Plegadis falcinellus (Linné).

Fourteen specimens, both sexes, young and adult, Berevo, Tulear, southern end of Lake Alaotra, Morondava, Maevatanana, Mahabo, and Miandrivazo, June, July, and September.

Perhaps a very large series of specimens might reveal some characters by which the Glossy Ibis can be divided into subspecies. I, however, am unable to find any constant differences between skins from Madagascar and from Europe or even from America.

Ciconiidae.

32. Anastomus lamelligerus madagascariensis Milne Edwards.

Seven specimens, both sexes, immature and adults, Sahabe River, Berevo, Morondava, and Mahabo, July.

This subspecies is easily separated from the African form by the character of the bill.

Scopidae.

33. Scopus umbretta bannermani Grant.

Five adult females, Morondava, Miandrivazo, Maevatanana, and twenty-five kilometers east of Tulear, July, August, and September.

Ardeidae.

34. Ardea purpurea madagascariensis Van Oort.

Seven specimens immature and adults of both sexes, Morondava River, Miandrivazo, Berevo, and thirty miles south of Berevo, and Upper Siribihina River, June, and July.

As pointed out by Van Oort the Purple Heron of Madagascar is a very distinct form, almost worthy of specific rank.

35. Ardea cinerea johannae Gmelin.

Two females, one adult, one immature, Berevo, and Morondava River, July 10, and July 20.

Gmelin's name was based on a bird from Anjouan, one of the

Comoro Islands, and must undoubtedly be used for the resident Grey Heron of Madagascar, which is characterized by dark grey upper parts, very stout bill, and very short wing-tip — the primaries, exceeding the secondaries by only 35 mm. The bare parts in the adult, according to Wulsin's notes, were colored as follows: — feet and tarsus greyish yellow; bare tibia, bright pink (this still shows in the skin as a garter-like marking around the leg); bill light yellow, below, darker above; skin around eye, greenish.

36. ARDEA HUMBLOTI Milne Edwards and Grandidier.

One fine adult ♂, Berevo, Siribihina River, July 9.

37. EGRETTA ALBA (Linné) sub. sp.?

Two adult males, southern end of Lake Alaotra, and Upper Siribihina River, July 5, and September 25.

The specimen taken September 25 at the southern end of Lake Alaotra, is in full breeding plumage, with a long train of dorsal plumes, extending 175 mm. beyond the tail. Its bill is black except at the base where it is yellowish; the bare tibia is black. The other specimen is apparently adult, or perhaps a bird of the previous year, but is not in breeding plumage, having no ornamental dorsal plumes. Its bill is wholly yellow. Both are small as compared with European skins, as the following measurements show; they differ but little in size from Australian specimens.

Mathews in Birds of Australia uses the name *Herodias alba syrmataphorus* Gould for the Australian form, and comments on the difficulty of satisfactorily dividing the Great White Egret into geographical subspecies.

African examples are also small, but Reichenow, (Die Vogel Afrikas), says that all that he has examined have yellow bills at all seasons.

The name the Madagascan form should bear, must, I think, be decided when much more material is available. Our two skins afford the following measurements: — M. C. Z. 77,431 ♂ adult (in breeding plumage): wing, 380; tail, 142.; tarsus, 149.; culmen 108. M. C. Z. 77,430 ♂ (adult?), (in non-breeding plumage): wing, 365.; tail, 138; tarsus, 160; culmen 110.

38. EGRETTA DIMORPHA Hartert.

Seven specimens, both sexes, three in the grey phase of plumage, three in the white phase, and one partly grey and partly white, fifteen kilometers east of Tulear, Tulear, Miandrivazo, Ambola, southwestern coast, and Berevo, June, July, and August.

This very distinct species, lately described by Hartert, had previously been confounded with *Demigretta gularis* (Bosc). It is a common heron in southwestern Madagascar.

39. NYCTICORAX NYCTICORAX NYCTICORAX (Linné).

Two specimens, an immature ♀ and an unsexed adult, Tulear, and Miandrivazo, June.

So far as I can judge by two examples, there is nothing peculiar about the Madagascan Night Heron. It is a rather uncommon bird on the island.

40. BUTORIDES ATRICAPILLA RUTENBERGI (Hartlaub).

Six specimens, immature and adults of both sexes, Tulear, Morondava, and Maevatanana, July, August, and September.

41. ARDEOLA IDAE (Hartlaub).

Twenty-two specimens, immature and adults of both sexes, Miandrivazo, southern end of Lake Alaotra thirty miles south of Berevo, fifteen kilometers east of Tulear, Sahabe River, Mahabo, Maevatanana, and Berevo, June, July, and August.

One old ♂, taken September 25, M. C. Z. 77,438, has the black- and white-striped occipital plumes very long, 174 mm. in length. No other specimen, among those in apparently full nuptial plumage approaches this one in this respect.

42. BUBULCUS IBIS IBIS (Linné).

Thirty-one specimens, immature and adult of both sexes, Miandrivazo, Upper Siribihina River, Maevatanana, Morondava, Tulear, Ambatondrazaka, sixty kilometers northwest of Antsirabe, fifteen miles south of Berevo, June, July, August, and September.

43. IXOBRYCHUS MINUTUS PODICIPES (Bonaparte).

Two adult males, Morondava, and Miandrivazo, June, and July.

ANATIDAE.

44. SARCIDIORNIS MELANONOTA (Pennant).

One adult female, southern end of Lake Alaotra, September 25.

45. NETTOPUS AURITUS (Böddaert).

Ten adults both sexes, Maevatanana, Tulear, Sahabe River, and southern end of Lake Alaotra, September.

46. DENDROCYGNA VIDUATA (Linné.).

Ten adults, both sexes, Upper Siribihina River, Miandrivazo, June, and July.

I have compared this series very carefully with both American and African specimens, and can find no real differences. The Madagascan birds are much stained on the white parts of the head and neck by bog iron.

47. DENDROCYGNA BICOLOR (Vieillot).

Six adults, both sexes, Tulear, and southern end of Lake Alaotra, September.

These examples also I am unable to distinguish from American specimens. The throat is usually darker and more reddish in our Madagascan skins, wholly due, I believe, to staining from bog iron, as the feathers underneath the very tips are of the same color as in specimens from other localities.

48. Anas melleri Sclater.

Nine adults, both sexes, southern end of Lake Alaotra, and Sahabe River, September.

49. Nettion punctatum madagascariensis Grandidier.

Nine specimens, adults of both sexes, southern end of Lake Alaotra, Tulear, Bevero, and Miandrivazo, June, July, and September.

Madagascan examples are a little smaller, and shorter winged, than African specimens, and are perhaps rather paler, more reddish brown, less dusky below.

50. Marila innotata (Salvadori).

Five adults, both sexes, southern end of Lake Alaotra, and Sahabe River, September.

51. Thalassornis insularis Richmond.

Three adults, ♂, ♀ ♀, Berevo, and near Ambatondrazaka, July, and September.

Phalacrocoracidae.

52. Phalacrocorax africanus pictilis, subsp. nov.

Twenty specimens, adults, and immature of both sexes, Miandrivazo, Maevatanana, Tulcar, Berevo, Morondava, and Upper Siribihina River, June, July, August, and September.

Type.— Adult ♂, M. C. Z. 77,555. Miandrivazo, Madagascar, June 26, 1915. F. R. Wulsin.

Characters.— Similar to *P. africanus africanus* (Gmelin) but larger; rectrices broader; spots on wings and scapulars larger, and rather differently shaped, extending straight across the tips of the feathers (in the African form the spot is usually deeper on the mid-rib than on the edges of the feathers).

Measurements.—Wing, of adults (both sexes included), 218–230; tail 163–171. In seven African skins of *P. africanus africanus* (Gmelin) the wing varies from 200–215, the tail 142–154.

53. ANHINGA VULSINI, sp. nov.

Six specimens, adults of both sexes, and two immature females with wholly buffy under parts, Maevatanana, Miandrivazo, and Tulear, June, and September.

Type.— Adult ♂. M. C. Z. 77,550. Maevatanana, Madagascar, September 9, 1915. F. R. Wulsin.

Characters.— Similar to *A. rufus* (Daudin) of Africa, but all the middle wing-coverts striped white (normal) or buff (stained with limonite) and black, exactly as in *A. melanogaster* (Gmelin), entirely lacking the broad brown band across the wing of the African species; under side of neck paler, more buff or sayal-brown, less chestnut. Similar also to *A. melanogaster* (Gmelin) of the Indo-Malayan region, and with exactly similar pattern of wing-coverts, but differing in lacking the white, brown-spotted throat and dark brown neck of that form; these parts being as in *A. rufus* except paler.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Tarsus*	*Exposed culmen*
77,549	♂ad.	350	268	44	80
77,550	♂ad.	335	252	40	78
77,554	♂ad.	337	250	39	79
77,552	♀ad.	346	261	43	77

Remarks.— I can find no name for the Madagascan Anhinga, which has by some authors been referred to *A. rufus*, by others to *A. melanogaster*. Its characters are curiously intermediate, and it is a very well-marked form.

I think that all the paler stripings of the wing-coverts, scapulars, and long tertials are normally white. In most specimens they are buff or clay color or even almost ferruginous, on the exposed portion of the feather, but white on the concealed basal part. This, I consider, is wholly due to staining from limonite, especially as in every specimen in the series some feathers can be found in the lesser coverts, middle coverts, or scapulars that are striped with silvery white; such white-striped feathers, moreover, always appear as if newly acquired.

Such staining is very prevalent among the Madagascan swimming, diving, and wading birds, on any part of the plumage white enough to show it.

FALCONIDAE.

54. POLYBOROIDES RADIATUS (Scopoli).

Eighteen specimens, adults and immature of both sexes, Berevo, Miandrivazo, Tulear, and Upper Siribihina River, June, July, and August.

55. ASTUR FRANCESII (Smith).

Eight specimens, adults and immature, both sexes, Morondava, Miandrivazo, and Berevo, June, and July.

56. BUTEO BRACHYPTERUS Hartlaub.

Twenty-six specimens, adults and immature, Upper Siribihina River, Antsoa, Morondava, Miandrivazo, near Ambatondrazaka, Berevo, and the Tulear region, June, July, and August.

57. MILVUS MIGRANS PARASITUS (Daudin).

Twelve specimens, adults and immature of both sexes, Miandrivazo, Morondava, Maevatanana, Begidro, and from forty kilometers N. N. W. of Antsirabe, June, July, and September.

These skins, upon comparison, prove to be quite the same as African examples.

58. BAZA MADAGASCARIENSIS (Smith).

One adult male Miandrivazo, June 23.

59. FALCO PEREGRINUS RADAMA Hartlaub.

One adult male Miandrivazo, June 21.

60. FALCO CONCOLOR Temminck.

One, unsexed, adult, Tulear.

61. CERCHNEIS NEWTONI (Gurney).

Thirty-five specimens, adults and immature of both sexes, Tulear, Morondava, Berevo, near Antsirabe, Nosy Asatra, thirty miles south of Ambatondrazaka, mouth of Onilahy River, Ambola, Lake Tsimanampetsotsa, Maevatanana, and Miandrivazo, June, July, August, and September.

As pointed out by Dr. C. W. Richmond, this species is dicromatic, having an erythristic phase, very similar to the erythristic phase of the Cuban Kestrel, *Cerchneis sparveroides* (Vigors).

62. DISSODECTES ZONIVENTRIS (Peters).

Five adult females, Tulear, Moronodava, and Maevatanana, July, August, and September.

PSITTACIDAE.

63. CORACOPSIS VAZA (Shaw).

Ten adults, both sexes, Miandrivazo, June.

64. CORACOPSIS NIGRA (Linné).

Three adults, ♂, ♀ ♀, Miandrivazo, June.

65. AGAPORNIS MADAGASCARIENSIS MADAGASCARIENSIS (Boddaert).

Fourteen specimens, adults and immature of both sexes, all from Miandrivazo, June.

66. AGAPORNIS MADAGASCARIENSIS ABLECTANEA, subsp. nov.

Three specimens, two adult males and one immature ♀, from the Morondava Delta, southwestern Madagascar, July.

Type.— Adult ♂, M. C. Z. 78,302. Morondava Delta, southwestern Madagascar, July 24, 1915. F. R. Wulsin.

Characters.— Similar to *A. madagascariensis madagascariensis* (Boddaert) of eastern, northern, and central Madagascar, but slightly larger; the green parts of plumage much bluer less yellowish green, the rump about cobalt-green, some of the feathers and the upper tail-coverts tipped with benzol-green; wings (except primaries which of course are dusky) and back, about zinc-green; belly and under tail-coverts, turtle-green; throat and breast purer grey due to the almost total absence of yellowish on the bases of the feathers of these parts.

Measurements.— Adult male (two specimens) wing, 91–95; tail, 55–56; tarsus, 12–13; culmen from cere, 11.

Remarks.— This very bluish form is in all probability confined to extreme southwestern Madagascar. It was referred to by Salvadori (B. M. Cat., **20**, p. 508) from Ankafana, s. Betsileo, and from Rodrigues (introduced). There are two specimens in the U. S. N. M. received from the Paris Museum collected by Besson in 1889. but labeled simply Madagascar.

LEPTOSOMATIDAE.

67. LEPTOSOMUS DISCOLOR (Hermann).

Eleven adults, both sexes, Tulear Region, Berevo, Upper Siribihina River, Miandrivazo, and Morondava, June, July, and August.

CORACIIDAE.

68. URATELORNIS CHIMAERA Rothschild.

Two adults, ♂ and ♀, twenty kilometers northeast of Tulear, taken together August 15.

ALCEDINIDAE.

69. CORYTHORNIS CRISTATA (Linné.).

Fourteen specimens, both sexes, Morondava, Upper Siribihina River, and Miandrivazo, June, and July.

70. Ispidina madagascariensis (Linné).

One adult ♂, Upper Siribihina River, July 3.

Upupidae.

71. Upupa marginata Bonaparte.

Twenty-two specimens, immature and adult of both sexes, Miandrivazo, Berevo, Morondava, Upper Siribihina River, Maevatanana, Tulear Region, and Lake Tsimanampetsotsa, June, July, August, and September.

Meropidae.

72. Merops superciliosus Linné.

Thirty-three specimens, immature and adults of both sexes, Maevatanana, Miandrivazo, Berevo, Tulear, and one hundred kilometers west northwest of Antockaba, June, July, August, and September.

Micropodidae.

73. Tachornis gracilis Sharpe.

Three adults, ♂, ♀ ♀, Miandrivazo and forty-five miles south of Berevo, June, and July.

Cuculidae.

74. Centropus toulou (Müller).

Fifty-one specimens, immature and adults of both sexes, including many males in the black breeding plumage, Miandrivazo, Berevo, Morondava, Mahabo, Lake Tsimanampetsotsa, Tulear Region, and Maevatanana, July, August, and September.

75. Coua cristata (Linné).

Fourteen specimens, both sexes, Morondava, Maevatanana, Morondava River, Upper Siribihina River, Berevo, and up to forty-five miles south of Berevo, July, and September.

76. Coua pyropyga Grandidier.

Seven specimens, both sexes, Morondava River, and Tulear Region, July, and August.

77. Coua verreauxi Grandidier.

Four adults, both sexes, Lake Tsimanampetsotsa, and six miles east of Tulear, August.

78. Coua olivaceiceps (Sharpe).

Six adults, both sexes, Tulear Region, and Lake Tsimanampetsotsa, August.

79. Coua cursor Grandidier.

Seven adults, both sexes, Tulear Region, and Lake Tsimanampetsotsa, August.

80. Coua coquerelli Grandidier.

Four adults, both sexes, Berevo, and Upper Siribihina River, July.

81. Coua gigas (Boddaert).

One adult male, Begidro, Upper Siribihina River, July 5.

Hirundinidae.

82. Phedina madagascariensis Hartlaub.

Four adults, both sexes, Upper Siribihina River, July 4.

Muscicapidae.

83. Newtonia amphichroa Reichenow.

Three adults, ♂♂, ♀, Tulear, and Lake Tsimanampetsotsa, August.

84. TCHITREA MUTATA (Linné).

Eleven specimens, both sexes, Tulear Region, Maevatanana, Miandrivazo, and Upper Siribihina River, July.

CAMPOPHAGIDAE.

85. GRAUCALUS CINEREUS (Müller).

Two adults, ♂ and ♀, Tulear, and Berevo, July 7, and August 12.

PYCNONOTIDAE.

86. HYPSIPETES MADAGASCARIENSIS (Müller).

Fifty specimens, both sexes, Berevo, Morondava, Tulear, Begidro, Lake Tsimanampetsotsa, Miandrivazo, and Beheloka, July, and August.

TIMELIIDAE.

87. BERNIERIA MADAGASCARIENSIS (Gmelin).

Five adults, both sexes, Miandrivazo, and Upper Siribihina River, June, and July.

TURDIDAE.

88. GERVAISIA PICA (Pelzeln).

Seventeen specimens, both sexes, Tulear, and Lake Tsimanampetsotsa, August.

89. COSSYPHA IMERINA Hartlaub.

Fifteen specimens, both sexes, Lake Tsimanampetsotsa, St. Augustin Bay, Beheloka, Anakao, and Nosy Asatra, August.

90. Saxicola sybilla (Linné).

Eight specimens, both sexes, Tulear Region, Miandrivazo, Ambatondrazaka, and Andaingo, June, August, and September.

Sylviidae.

91. Cisticola cherina (Smith).

Four adults, both sexes, Tulear, and Morondava, July, and August.

92. Nesillas lantzi Grandidier.

Five adults, both sexes, Tulear, and Lake Tsimanampetsotsa, August.

93. Calamocichla newtoni (Hartlaub).

One adult ♂, Sahabe River, September 25.

94. Neomixis tenella Hartlaub.

Fifteen specimens, both sexes, Tulear, Lake Tsimanampetsotsa, and Upper Siribihina River, July, August, and September.

Vangidae.

95. Xenopirostris xenopirostris (Lafresnaye).

Seven specimens, adults of both sexes, and one immature ♂, Tulear Region, and Lake Tsimanampetsotsa, August.

96. Artamia leucocephala (Gmelin).

Seven specimens, adults, and immature, both sexes, Miandrivazo, Morondava, Berevo, and Upper Siribihina River, June, and July.

97. ARTAMIA BICOLOR (Linné).

One adult ♂, Upper Siribihina River, July 3.

98. ABBOTTORNIS CHABERT (Müller).

Ten specimens, both sexes, Tulear, Maevatanana, Miandrivazo, Morondava, Berevo, and Anakao to Nosy Asatra, June, July, August, and September.

99. VANGA CURVIROSTRIS (Gmelin).

One adult, unsexed, near Tulear, August.

ZOSTEROPIDAE.

100. ZOSTEROPS MADERASPATANA (Linné).

One adult ♂ Miandrivazo, June 28.

NECTARINIIDAE.

101. CINNYRIS NOTATUS (Müller).

One adult ♂ Miandrivazo, June 24.

102. CINNYRIS SOVI-MANGA (Gmelin).

Ten specimens, adults, and immature, both sexes, Miandrivazo, Ambola, Upper Siribihina River, and Tulear, June, July, and August.

MOTACILLIDAE.

103. MOTACILLA FLAVIVENTRIS Hartlaub.

Two adult females, Miandrivazo, and twenty miles south of Ambatondrazaka, June 21, and September 21.

ALAUDIDAE.

104. MIRAFRA HOVA Hartlaub.

Fifty-five specimens, both sexes, Tulear, Lake Tsimanampetsotsa, Morondava, and eight miles north of Andaingo, June, July, August, and September.

PLOCEIDAE.

105. SPERMESTES NANA (Pucher).

Seven specimens, both sexes, Morondava, Morondava River, and Tulear, July, and August.

106. FOUDIA MADAGASCARIENSIS (Linné).

Twenty-six specimens, both sexes, only two males in scarlet breeding plumage, Morondava, Morondava River, Berevo, Anakao to Nosy Asatra, Maevatanana, Tulear, and Miandrivazo, June, July, August, and September.

107. FOUDIA SAKALAVA (Hartlaub).

Five specimens, all males in post-nuptial plumage, Morondava, July.

EULABETIDAE.

108. FALCULIA PALLIATA Geoffroy St. Hilaire.

Seven specimens, both sexes, Morondava River, Miandrivazo, and Tulear, June, July, and August.

DICRURIDAE.

109. EDOLIUS FORFICATUS (Linné).

Thirty-three specimens, adults, and immature of both sexes, Tulear, Miandrivazo, Beheloka, Morondava River, Berevo, Lake Tsimanampetsotsa, Morondava, and Upper Siribihina River, June, July, August, and September.

CORVIDAE.

110. CORVUS SCAPULATUS Daudin.

Nine adults, both sexes, Tulear, Morondava, Lake Tsimanampetsotsa, and the neighborhood of Miandrivazo, June, and August.

4.— MAMMALIA. By GLOVER M. ALLEN.

Specimens representing twenty-four species were obtained by Mr. Wulsin and of these three, the Musk-Shrew, the Rasse, and the Roof Rat, are introduced from the East. Of the rest there are twelve lemuroids, four insectivores, three bats, the Cryptoprocta, and the native River Hog. The Eastern Forest, as might be expected, proved most rich in species, and here most of the lemuroids and insectivores were secured. In the dry country of the southwest part of the island, the Verreaux's Sifaka and the Red-fronted Lemur were the common species. No success attended the efforts to trap the small native rodents or carnivores. Two skins of a free-tailed bat (Chaerephon), here named as new, represent the group with a white belly and axillary spot, replaced on the mainland of Africa by *C. emini.*

CENTETIDAE.

1. CENTETES ECAUDATUS (Schreber). TENREC.

A single specimen from Ambatondrazaka differs greatly from the three others previously in the Museum's collection, in its much less spiny pelage, which is nearly uniform dark reddish brown. It is unfortunate that the three specimens are without indication of exact locality, for their uniformly pale coloration suggests that more than one geographic race may be found to occur.

2. ERICULUS SETOSUS (Schreber). HEDGEHOG TENREC.

Seven specimens from Didy, Eastern Forest.

3. Ericulus telfairi pallescens Thomas. Pale Hedgehog Tenrec.

Two specimens of this smaller species. One is much darker than the other, but both have the white-tipped spines. The one from Miandrivazo is dark brown; the one from northeast of Tulear a distinct pale chestnut at the bases of the spines.

4. Hemicentetes semispinosus (G. Cuvier). Streaked Tenrec.

Six skins, fairly uniform in appearance, except that one is nearly white- instead of yellow-streaked, are all from Didy, Eastern Forest.

Soricidae.

5. Pachyura caerulea (Kerr). Common Musk Shrew.

One specimen of this introduced species. It was apparently well-established on the island as early as 1855, when Fitzinger described Madagascan specimens as *P. auriculata.* Of the two minute species of native Crocidura, no specimen was found.

Pteropidae.

6. Pteropus rufus rufus E. Geoffroy. Rufous Fruit Bat.

Nine skins and skulls from Berevo, Upper Siribihina River, Miandrivazo, and twenty kilometers east of Tulear are referable to the typical subspecies.

Emballonuridae.

7. Emballonura atrata Peters. Dusky Sheath-tailed Bat.

Two in alcohol, from the Tanandra River, near Tamatave.

MOLOSSIDAE.

8. CHAEREPHON LEUCOSTIGMA, sp. nov. WHITE-SHOULDERED BAT.

Type.— Skin and skull. Adult ♀ M. C. Z. 16,344, Tananarive, Madagascar, December, 1915. Gift of F. R. Wulsin.

General characters.— A medium-sized species (forearm 42.5–44.5), rich dark reddish brown above, paling to greyish brown on the sides; entire midventral area from chin to anus, and a streak at the base of humerus whitish. Anterior upper premolar minute, in the outer angle between canine and posterior premolar.

Color.— Upper parts, from forehead to base of tail a rich dark reddish brown, between 'auburn' and 'mars brown' of Ridgway, 1912. Along the sides of the body this color pales to a 'wood brown'. Midventral area from the practically naked chin to the root of the tail, and an elongated spot at the axilla, white or whitish. The membranes are dark, except for a narrow whitish area, visible from the lower side, between the forearm and fifth finger. They are naked except for a narrow line of reddish brown hairs along the outer margin of the front of the ear and a line along the outer edge of the forearm.

Skull.— The skull is provided with a prominent sagittal crest, which in the type, though partly broken, must have been at least a millimeter high. The upper incisors are separated by a narrow space, and their inner edges parallel; face of the upper canines broadly grooved. The anterior upper premolar is very minute, scarcely equalling the cingulum of the canine. It is wedged in the outer angle between the canine and the large posterior premolar, both of which are in contact on the line of the tooth-row. The lower incisors are probably four in number (though the type and paratype lack the outer left-hand tooth). They are distinctly bifid, the inner lobe larger than the outer, and the inner incisor of each side slightly overlapping the smaller outer tooth. The cingula of the lower canines nearly meet well above these minute incisors.

Measurements.— Of the dimensions that follow, the first is in each case that of the type, 16,344; the second that of the paratype, 16,345. Total length, dry skin, 102, 100 mm.; forearm, 44.5, 42.5; thumb 9.3, 8; third metacarpal, 45.5, 42.5; first phalanx (3d digit), 20.4, 18.7; second phalanx (3d digit), 20.5, 18.7; fifth metacarpal, 29, 28; fifth finger, 47.5, 44.5; tibia, 18, 16; hind foot, 13.2, 11.6.

Skull of type: — greatest length, vertex to front of i^1, 22.2 mm.;

basal length, 16.7; palatal length, 9; mastoid breadth, 12; zygomatic breadth, 13.4; breadth outside m^3, 10; length of upper tooth-row from front of canine to back of m^3, 8; lower tooth-row from front of canine to back of m_3, 8.9.

Remarks.— The two specimens seem to show a close relation to the continental *C. emini* DeWinton, the type-locality of which is Mosambiro. The color-pattern, including the white axillar spot, is similar in both, but the Madagascan species is brighter, reddish brown, instead of sooty. The tooth-row in the latter is more compressed than in *C. emini* so that the small upper anterior premolar instead of standing directly in the tooth-row, is crowded quite outside, and stands in the angle between the canine and the posterior premolar, which are in contact. This condition is likewise found in the larger *C. angolensis*, the Madagascan record of which may in reality refer to the new species here described. Of other species recorded from Madagascar, Grandidier's *Nyctinomus leucogaster* appears to be one of the white-winged group, represented on the mainland of Africa by *Chaerephon hindei*, his *C. miarensis* and Thomas's *C. fulminans* are larger species; while Jentink's *C. bemmeleni* is brown above and below, with the small upper premolar standing in the tooth-row.

VIVERRIDAE.

9. VIVERRICULA RASSE (Horsfield). RASSE.

One specimen of this introduced carnivore was taken five miles south of Berevo.

CRYPTOPROCTIDAE.

10. CRYPTOPROCTA FEROX Bennet. CRYPTOPROCTA.

A skin and skull, obtained six miles northeast of Tulear.

MURIDAE.

11. RATTUS RATTUS FRUGIVORUS Rafinesque. ROOF RAT.

A series of over twenty skins is much yellower in tone than the greyish Roof Rat of the southern United States, and is doubtless referable to this subspecies.

LEMURIDAE.

12. PROPITHECUS DIADEMA Bennett. DIADEMED SIFAKA.

One fine adult male from Didy, Eastern Forest.

13. PROPITHECUS VERREAUXI Grandidier. VERREAUX'S SIFAKA.

Fifteen skins and skulls, all but three of which are males. This species was common on the Upper Siribihina River, and at a locality twenty-five kilometers east of Tulear, in open country. The series is remarkably uniform in coloration; the dark crown-patch varies from black to a blackish brown, the pale grey area on the back varies to nearly all white in some, and there is a distinct median line of pale rufous on the throat and chest in others, but apart from these slight deviations, they are very true to type.

14. LICHANOTUS LANIGER (Gmelin). WOOLLY AVAHI.

One specimen from the Eastern Forest.

15. LEMUR NIGRIFRONS E. Geoffroy. BLACK-FRONTED LEMUR.

One from Didy, Eastern Forest.

16. LEMUR FULVUS E. Geoffroy. FULVOUS LEMUR.

One from Didy, Eastern Forest.

17. LEMUR RUFIFRONS Bennett. RED-FRONTED LEMUR.

A fine series of six males and ten females, all from localities on the Upper Siribihina River and some thirty miles south of Berevo. The sexual dichromatism in this species is very striking; but apart from this, the series of each sex shows extremely little variation in color. This and Verreaux's Sifaka were the two species of Lemurs most frequently met with.

18. LEMUR CATTA Linné. RING-TAILED LEMUR.

Two specimens from a locality 25 miles east of Tulear. This ground-living species has a restricted range in the dry country of the south and southwestern portion of the Province of Tulear.

19. LEMUR VARIEGATUS Kerr. RUFFED LEMUR.

A handsome female from a locality one hundred miles west of Tamatave.

20. MYOXICEBUS SIMUS (Gray). BROAD-NOSED GENTLE LEMUR

Two specimens from near Ambatondrazaka seem referable to this species rather than to *M. griseus.*

21. LEPILEMUR MUSTELINUS I. Geoffroy. WEASEL LEMUR.

One from Didy, Eastern Forest.

22. MICROCEBUS MURINUS (Miller). MILLER'S DWARF LEMUR.

Two specimens, one in the rufous phase from Didy, Eastern Forest, the other in the grey phase from Tulear.

DAUBENTONIIDAE.

23. DAUBENTONIA MADAGASCARENSIS (Gmelin). AYE-AYE.

A skin and skeleton of this remarkable animal were obtained in northern Madagascar, from Fénérive on the Maningory River.

SUIDAE.

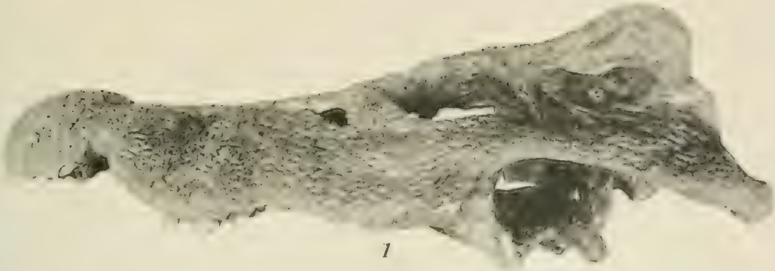
24. POTAMOCHOERUS LARVATUS (F. Cuvier). MADAGASCAR RIVER-HOG.

One skull from the east coast.

EXPLANATION OF THE PLATES.

PLATE 1.

Lateral (Fig. 1), dorsal (Fig. 2), and ventral (Fig. 3) views of the skull of *Crocodilus robustus* Vaillant and Grandidier.



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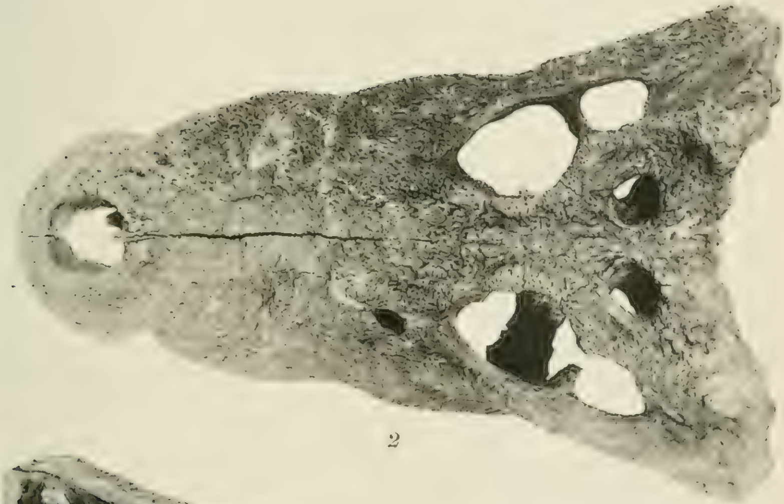

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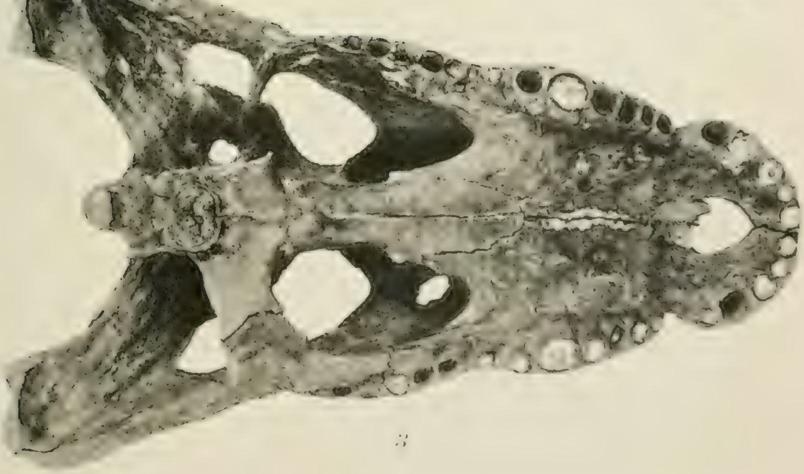

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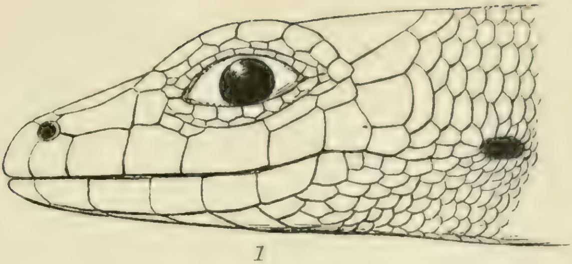
PLATE 2.

PLATE 2.

Fig. 1.— Lateral view of the head of *Scelotes brunneus* Barbour.
Fig. 2.— Dorsal view of the same.
Fig. 3.— Lateral view of the head of *Sepsina vulsini* Barbour.
Fig. 4.— Dorsal view of the same.



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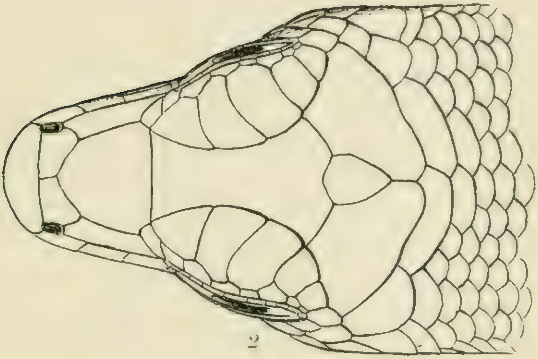

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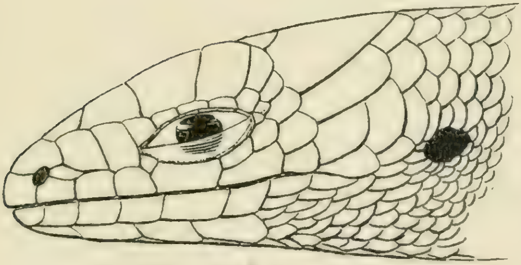

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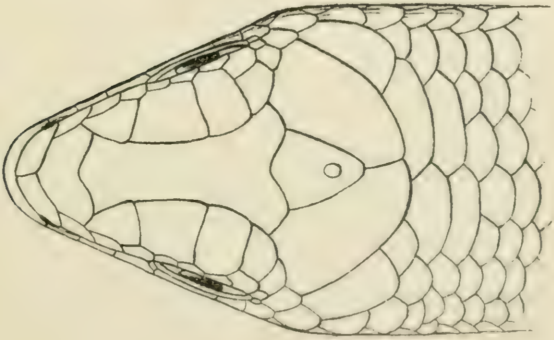

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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXI. No. 15.

THE HARVARD DEEP-SEA THERMOGRAPH.

By Harry Clark.

With Five Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
March, 1918.

No. 15.— *The Harvard Deep-Sea Thermograph.*

By Harry Clark.

The study of ocean temperatures interests the oceanographer because it furnishes a means of tracing out both the horizontal and vertical movements of the water below the surface. It is also of use to the biologist because the distribution of marine organisms is determined largely by temperature. The temperature of surface water varies within wide limits. In high latitudes it may go below 0° Centigrade in winter and rise to 5°, more or less, in summer. In the tropics it averages 27°, with a variation of perhaps 4° either way. Below the surface the temperature falls very rapidly at first, and the seasonal differences and other irregularities become less marked. At 500 fathoms, in middle latitudes, the temperature commonly varies from 4° to 8°, and at great depths approximates 0° throughout the year. A modern discussion of ocean temperatures is contained in The depths of the ocean by Murray and Hjort (London, 1912).

A surface temperature may be taken by drawing a bucket of water and putting an ordinary thermometer in it. Several methods have been used for work at small depths. Well-insulated water bottles can be filled at considerable depth, and then drawn up rapidly and tested before the contents have appreciably changed in temperature. The Pettersson-Nansen bottle has been used with success at several hundred fathoms. The thermophone, first devised by Warren and Whipple and described in the Technology quarterly, July, 1895, has been suggested for this work. This device measures temperature by determining the electrical resistance of a wire having a large known temperature-coefficient. It has been used with success at 100 fathoms, but for deep work the insulation of the wires presents a problem. It is difficult to handle a long insulated wire because its weight is great compared to its tensile strength.

The most widely used instrument is a special mercury thermometer, such as that made by Negretti and Zambra of London. A constriction of the capillary near the bulb allows the mercury column to separate at a definite point when the instrument is inverted, and the peculiar form of the capillary near the constriction makes it impossible for any subsequent change of temperature to change the quantity of mercury which has fallen to the other end of the tube. The thermometer proper is contained in a glass-tube which serves as a protection against water pressure, the thermal contact between the bulb and the outer tube being made through mercury. This apparatus, mounted in a frame, is lowered on a wire to the required depth, and is then inverted either by dropping an iron ring down the wire, or by means of a small propeller which spins if the wire is pulled up a short distance. The temperature is thereby registered, and can be read off at any time after the instrument has been hauled up.

Measurements at small depths are not hard to make, but at great depths they are more difficult and require a much longer time. The weight of the wire presents a difficulty, and the pressures which the apparatus must withstand are very great. Besides, if the results at great depths are to be of value, the readings must be more precise, because the variations of temperature are so much smaller there than near the surface. Of the methods mentioned above, that involving the reversing mercurial thermometer is the only one which has been used at great depths with notable success, and even with this the results are not uniformly accurate and reliable. The problem of designing and constructing a recording thermometer for deep-sea work, embodying some of the main principles described in this paper, was suggested to the writer in October, 1915 by Prof. Reginald A. Daly. To aid in defraying the cost of designing and manufacture two liberal grants were made from the Bache Fund of the National Academy of Sciences, at the request of Professor Daly, who supplemented the amount by his own gift and obtained generous subscriptions from Messrs. R. L. Agassiz, Livingston Davis, and G. B. Leighton.

General Plan of the Thermograph.

The problem of constructing a satisfactory deep-sea thermograph consists essentially in devising a mechanism which will adjust itself quickly to temperature changes, is sufficiently compact, of such a shape that it can be protected from the action of water and great hydrostatic pressure, and more accurate in recording than an ordinary mechanical thermograph. It need not be particularly light, for in any case its weight will be small compared to that of the great length of wire by which it will be lowered. The mercury thermometer in glass was chosen as the most reliable means of measuring temperature, and photography as the best means of recording its readings. Errors in measurement are thus reduced to a minimum. If any photograph at all is obtained it is a truthful record of the thermometer reading.

The light for the photographic work is produced by a small electric lamp operated by dry cells. After traversing a peculiar optical system necessitated by the general shape and compass of the apparatus, it passes through the glass thermometer-stem in a parallel beam and falls upon a film. The temperature is afterwards measured from the height of the shadow which the mercury column casts on the film. The length of exposure, and the intervals at which exposures are made, are governed by a clockwork which causes the lamp to light at the proper time, and afterwards moves the film along to prepare for the next exposure. An intermittent record like this is preferable to a continuous one, because it simplifies the time record on the film. Before the apparatus is put overboard its clock should be compared with the observer's watch. It will then be known at what times on the watch the records are to be made, and at such times the operator will note the depth as indicated by the amount of wire paid out. If the temperature gradient is small, or if great accuracy is not required, the thermograph may be lowered slowly and continuously. If the greatest accuracy is desired the operator should lower it quickly after each exposure and then allow it to remain at its new level until the next record has been made.

The photographic apparatus, lamp, batteries, films, thermometer, and clockwork taken together constitute the *works* of the thermograph. They are enclosed in a strong water-tight steel shell, called the *flask*. The works, Plate **1**, fig. 1, were made by C. L. Berger and Sons, Roxbury, Mass. The length without thermometer is 10 inches, and the diameter $2\frac{3}{8}$ inches. In fig. 2, Plate **1**, the *clockwork cover*, *front casting*, and *thermometer* have been removed. In all of the figures a given part of the apparatus is always referred to by the same letter.

Photographic Unit.

The *photographic unit*, except for its front casting, is shown, fig. 4, Plate **2**. It is made up of four brass castings, called *front*, *back*, *top*, and *bottom* respectively, so fitted together as to enclose a light-tight cavity, and contains the lamp, batteries, optical system, and films. The front casting is shown, fig. 5, Plate **2**. Fig. 3, Plate **1** is a cross-section of the photographic unit, the cross-hatched areas being the sections of the front and back castings. The film is shown passing between the spools *a*, *a* over the roller *b*, and the thermometer-tube is shown at *c*. The optical system is contained in the front casting. The battery-cells are contained in the holes *d*, *d*.

Plate **1**, fig. 2 and Plate **2**, fig. 4 show the centres *e*, *f*, *g*, *g*, which hold the two film-spools. The *upper* centres *e* and *f* are shown in detail Plate **3**, fig. 8, 9. One of them, *e*, is turned positively by the clockwork, while the other, *f*, is somewhat restrained in its motion by a spring. The *lower* centres, *g*, *g*, Plate **1**, fig. 2, Plate **2**, fig. 4, Plate **3**, fig. 10, 11, can be withdrawn sufficiently to permit the spools to be put into place. When they are returned to position they are locked by the two small cranks *h*, *h*, Plate **1**, fig. 2, and Plate **3**, fig. 11. A spring, *i*, Plate 1, fig. 2, Plate **2**, fig. 4, tipped with ball-bearings, keeps the film and paper tightly rolled. In fig. 2 and 4 *j* is a red window for adjusting the film for its first exposure, and *b* is the roller over which the film passes.

The top casting is shown together with its accessory parts in Plate **3**, fig. 8, 9. The tube *k* provides space for the expansion-chamber of the thermometer. Insulated studs, *l*, *l*, are connected to the batteries below through spring contacts, and *m* is an insulated conductor to carry current to the clock. Figures 10 and 11, Plate **2**, show the bottom casting with other parts. It is fastened to the back casting by three screws. The cap *n*, which holds the battery-cells in place, contains an insulated insert, as shown, to connect them in series. The lamp-socket *o* can be removed by turning aside the connector *p*. The casting is fitted with a key and a latch, *q*, to hold the thermometer in the right position. The front casting containing the optical system is held in place by two bolts, *r*, *r*, fig. 11, Plate **3**. They pass through the bottom casting, through the holes *s*, *s*, Plate **1**, fig. 3 and Plate **2**, fig. 5, into the top casting, and are locked in place by a quarter turn.

Optical System.

It would be easy to photograph the thermometer if plenty of room were available. Since in a restricted space four inches of stem are to be photographed on a 4-inch film, the problem can scarcely be solved with lenses. The special optical scheme was devised by Professor Daly. When the front casting is in place it fits over the shield *t*, Plate **1**, fig. 2, Plate **2**, fig. 4, and Plate **3**, fig. 11, to make a light-tight joint. The lamp is then directly beneath the cylindrical hole *u*, Plate **1**, fig. 3 and Plate **2**, fig. 5, which, being lined with white paper, is diffusely illuminated. Parallel with this hole and connected with it by a wide slot is another smaller one at *v*, Plate **1**, fig. 3, which contains the collimator, Plate **2**, fig. 6. The collimator consists of a frame carrying many thin blackened metal plates, equally spaced and parallel to each other, the arrangement being similar to a window-blind. The plates are $\frac{3}{8}$ inch long, .003 inch thick, and .04 inch apart. The light when it has passed between the plates is nearly *parallel,* considered vertically, but is still *diffuse* in its horizontal aspect. It then passes in succession through another slot, the thermometer-stem, a third very narrow slot (.008 inch), and falls upon the film. The stem is orientated so that its eccentric capillary lies very close to the narrow slot which throws a *slit image* of the capillary and its mercury column on the film. A specimen film is shown, Plate **2**, fig. 7. The thin white line in the middle of each record is the shadow of the mercury. The double space near the middle of the film is made once an hour by the clockwork, to facilitate counting.

Thermometer.

The thermometers, two of which are shown, Plate **4**, fig. 12, were made by Henry J. Green of Brooklyn, N. Y. They are made of special tubing $\frac{3}{16}$ inch in diameter, having the eccentric flattened capillary required by the special optical system. Since the temperatures aboard ship will often be well above the highest water temperature, an expansion-chamber is provided at x. The bulb is $\frac{3}{8}$ inch in diameter, and may have any length up to $3\frac{1}{2}$ inches. Thus although the optical system demands a broad capillary (.01 inch), it should be possible by a proper choice of tubing to make a thermometer of greater sensitiveness than will ever be needed. The photographic record includes nearly four inches on the thermometer-stem. If it may be read to .01 inch we shall expect an accuracy of .1° over a range of 36° or of .03° over the 10° range which will be used in deep water. The stems are not graduated. The temperatures are found from the photographic record by measuring the distances between the top of the mercury and the upper end of the image. If desired a fiducial mark could be made on the thermometer-stem from which measurements could be taken. No appreciable error is introduced by distortion of the film in development. The calibration is accomplished by allowing the thermograph to record the temperature of water in which is placed a standard thermometer. As shown in Fig. 12 the thermometer is mounted in a steel sleeve, being held firmly in place by a packing gland containing cotton cord and shellac. A slot cut in the sleeve makes it impossible to orientate the thermometer wrongly when assembling the apparatus.

When not in use the stem and bulb are protected by brass caps, Plate **4**, fig. 12. Several interchangeable thermometers, each properly mounted, should accompany the instrument.

Films and Battery.

The temperature records on the film are about .1 inch apart. A 10-hour record of temperatures taken at 3-minute intervals requires 23 inches of film. This quantity of film, together with the necessary black paper, can be made into a roll somewhat smaller in diameter than those on the market. To save room the special spool, Plate **4**, fig. 12, is used. It carries a film four inches wide, and has an outside diameter of $\frac{7}{8}$ inch. These spools fit better and run more smoothly than commercial ones, a necessary consideration since they are turned by clockwork of limited power.

When film which is attached to paper in the usual way is rolled from a full spool to an empty one, the portions of paper and film between the spools quickly become unequal in length. Instead of lying flat against the paper the film buckles. Reference to Plate **1**, fig. 3 shows that the position of the film at the point of exposure is determined by the steel roller *b*. To prevent buckling, so that the film may lie close to the roller, a special method of attachment is used. The film is attached at both ends, an excess of paper being left between the places of attachment. The extra paper forms a plait or fold when the film is put on a spool. When the film is unrolled in the thermograph, this plait unrolls so that the film is held taut. When all the film has reached the second spool the extra paper forms a plait at the other end of the film and rolls up neatly. These special rolls are quickly prepared by a device not here described.

If, on the other hand, black paper is dispensed with and the naked film is inserted in the dark room, about 55 inches of film can be accommodated and wound off by the clockwork. In practice it may be found most convenient to use naked film, thereby also lessening friction and the danger of jamming during a long run. Ordinary 10-exposure, four by five Kodak film-rolls may be used.

Small dry cells furnish the current for the electric lamp. An exposure of $\frac{1}{2}$ second produces a photograph, so a battery giving two or three minutes of intermittent service will suffice for a day's work. At the time when the thermograph was designed very small cells were not on the market. Special cells like those shown, Plate **4**, fig. 12 were therefore made. The zinc cans were made by Mr. V. Seitz at the Cruft Laboratory, Harvard University, and were filled and prepared for use by the Secret Service Battery Company of Everett, Massachusetts, through the kindness of Mr. F. D. Harper. Three cells are required to light the lamp, but space is provided for a fourth, to be used when the cells deteriorate with age. One commercial three-cell lamp has been found still in good order after enduring about 2,000 flashes with four of the dry cells in the circuit — a battery of four cells proved still useful after 800 flashes.

Clockwork.

The *clockwork unit*, Plate 4, fig. 13, was made by the E. Howard Clock Company. It is arranged in three levels, and is attached to the upper casting of the photographic unit. Undue strains are prevented by making it sufficiently small so that it does not touch the cover. In the upper level is the clockwork proper, that is, the timekeeping mechanism, and the electrical contact device for lighting the lamp. The wheels in this level are referred to as the *upper train*. The lower level contains the *lower train*, which serves to roll the film-spool; and the mainspring occupies the middle level. Save for a few alterations the upper train is similar to that used in the stock model known as the No. 16 time-clock made by the E. Howard Clock Company. The escapement is identical with the one used in that model. It can be removed as a single unit from the clock by merely taking out two screws, thus simplifying the operations of cleaning and repairing.

The mainspring, which consists of two springs in tandem, operates both the upper and lower trains. A great latitude in the use of the thermograph is gained by this arrangement. The spring is designed to operate the thermograph for ten hours, making a record every three minutes.[1] If, however, it is desired to make records over a longer time, the exposures may be made at intervals as great as an hour, in which case the mainspring will devote nearly all its energy to the clockwork proper and will keep it going a week or more. The spring communicates through the winding arbor with the lower train, the first member of which is a combination of two wheels and disc on a stud, Plate 4, fig. 13, a. The two wheels are connected by a ratchet, as are also the lower wheel and disc. By means of two pins the disc drives the piece *e*, Plate **3**, fig. 8, 9, which turns the film-spool. The lower ratchet enables the operator to turn the film-spool forward by means of the clock-key, so that when a new film has been put in place and the front casting is replaced, he can roll up the black paper quickly and bring the film into position for the first exposure. The other ratchet allows the winding arbor to be turned backward when the spring is being wound. The rest of the lower train consists of five wheels, the last of which carries a fan to govern the speed.

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[1] If film without black paper is used, the present clockwork will run fifteen hours, with one winding, giving 300 pictures.

The *centre arbor* of the upper train, which makes one revolution per hour, projects through the upper plate of the clock and carries the cam shown at *B*, Plate **4**, fig. 13. The exposures are regulated by the notches in the circumference of this cam. Several interchangeable cams with intervals from two minutes to an hour are provided. When the pawl *C* falls in a notch, the corresponding motion of the lever *D* unlocks the lower train and allows it to roll up about $\frac{1}{10}$ of an inch of film. *C* also carries two screws, *E* and *F*, the functions of which will appear presently.

Since only a very short exposure is required to impress the film, it is desirable that the length of exposure be accurately timed. The cams which regulate the exposure should then be put on a rapidly moving arbor. Two very small cams are used, and they are placed one above the other on the arbor of the *fifth* wheel, which makes one revolution per minute. Two long thin springs provided with contact-points, one of platinum, the other of ivory, press against these cams. Each therefore snaps forward when its cam reaches a definite position, the one to *make* the electric contact, the other to *break* it. The time of exposure thus depends on the relative angular position of the two cams, one of which is adjustable. This device would make an exposure every minute were it not for the screw *E*, which resists the motions of the contact springs at all times save when the lever *C* falls into a *deep* notch in its cam. One *shallow* notch is cut in each of these cams and serves to double-space the records on the film at the end of each hour. In addition to its two small cams the arbor of the fifth wheel carries a radial spring which, as it revolves, passes very near the screw *F*. If the crank *G* be thrown to the left, Plate **4**, fig. 13, it withdraws lever *C* to an abnormal position, so that screw *F* will engage the radial spring as it comes around to a definite position and will thus stop the clock. When the crank *G* is thrown right again the clock will start on an exact minute. The operator can thus make the clock register with his watch.

Flask.

Figure 14, Plate 5 shows the flask complete, a section of its lower part, and some small pieces. The flash is cylindrical in general shape, 3-$\frac{3}{16}$ inches in diameter, and about twenty-one inches in length over all. For the greater portion of its length it has an inner diameter of 2-$\frac{7}{16}$ inches, the walls being $\frac{3}{8}$ inch thick. Below this portion it tapers off and is continued as a small cylindrical tube $\frac{3}{4}$ inch in diameter outside and five inches long with walls only $\frac{1}{8}$ inch thick. The flask here shown was made by the Hoffecker Company of Boston from a single forging of chrome-vanadium steel. Very little is known about the design of tubes to withstand great external pressure, and it is hard to say to what depth this flask may be sent safely. It may be found that for 5,000-fathom work the walls must be thicker.

The small pieces, Plate 5, fig. 14, constitute the plug which closes the upper end of the flask proper. The stud H passes freely through the piece I, but is prevented from rotating by the nearly square head at J, which fits in socket K. Four screws prevent this head from falling out of the socket, but it may move up and down freely $\frac{1}{16}$ inch. This shake is an essential feature. Pieces H and I need not be taken apart save for cleaning. To put the plug in place this unit is first inserted in the flask proper and screwed down until it *nearly* bottoms. The piece I may be required to withstand a force as great as 35 tons. It is essential, therefore, that the stress come on the threads rather than on the shoulder of the flask. Next there are put on three packing rings in order — fibre, soft rubber, and fibre. Above these is placed the nut L, which is set up tight with a wrench. As the water-pressure on this plug increases, the rubber is compressed slightly and the tension of the stud on the nut decreases and finally disappears. Since the stud may slide freely through the nut L, the force due to water pressure on the whole plug will be transmitted to the packing. The cross-section of the whole plug is about $\frac{1}{5}$ greater than that of the packing ring, and consequently the rubber will be subjected to a pressure $\frac{1}{5}$ greater than the water-pressure outside, which will prevent leakage at the edges. However, the excess is not great enough to spread the flask nor to drive the rubber out through the joints.

A collar of wrought iron shrunk on the flask and held in place by a shoulder is provided with a pair of trunnions to carry the bail by which the flask is supported.

The inner diameter of the flask is $\frac{1}{16}$ inch greater than the diameter of the works, and the inner diameter of the tube at the bottom of the flask is $\frac{1}{8}$ inch greater than that of the thermometer-bulb. There is little danger of breaking the bulb therefore when inserting the works into the flask. The tapered portion of the sleeve in which the thermometer is mounted steers the works into a central position, and the shoulder of the sleeve, Plate **1**, fig. 1 *y*, Plate **4**, fig. 12 *y*, rests upon the shoulder, Plate **5**, fig. 14 *M*, of the flask, a tight joint being secured by a rubber washer placed on the thermometer-sleeve. At *z*, Plate **1**, fig. 1, is shown a groove cut in the works, which carries a wire-spring of peculiar shape. This spring holds the upper portion of the works in a nearly central position in the flask, and the spider-spring *N*, Plate **5**, fig. 14, attached loosely to the plug, presses down upon the cover of the works. Supported in this way the works cannot be injured by a slight distortion of the flask.

The thermometer-bulb projects into the long narrow portion of the flask and good thermal contact is insured by nearly filling the space between them with mercury. If the lengths of the various interchangeable thermometers be properly calculated, they will all work with the same quantity of mercury in the flask. Since the bulb is in good thermal contact with the sea-water and in very poor contact with other parts of the apparatus, through glass only, the temperatures of the works and upper portion of the flask have little effect on the records. Experiment shows that under the most unfavorable conditions the thermometer will come to the temperature of the water closer than .1° in about one minute.

The lower narrow part of the flask is protected by a guard, Plate **5**, fig. 14, to which for work at considerable depths there should be attached, a short wire carrying a heavy weight.

The thermograph has not yet been tested in deep water. It has been tried in the Charles River and in the laboratory, and has been found to work properly. The records may be read with an accuracy of about .05° when using the range −2° to 33°, and are correct within these limits. If the collimator, Plate **2**, fig. 6, contained more plates the accuracy of reading would be increased. There is no reason why one should not be able to read .01° in this way. Until the instrument was constructed it was not known how much exposure the film would require. It has since been found that there is plenty of light to warrant the use of a collimator with plates much closer together.

If it should prove desirable to obtain more than 200 exposures on a single film, a slight alteration of the clockwork and a narrow stop placed before the film would make it possible to get about 800 records with one winding of the spring. This would mean a record every three minutes for forty hours.

EXPLANATION OF THE PLATES.

PLATE 1.

Fig. 1. Thermograph ready for insertion in protective steel shell.
Fig. 2. Clockwork and view of interior of the rear casting.
Fig. 3. Section showing the optical system, *u-v-c*, and related parts.
Uniform scale: 47 per cent of natural size.

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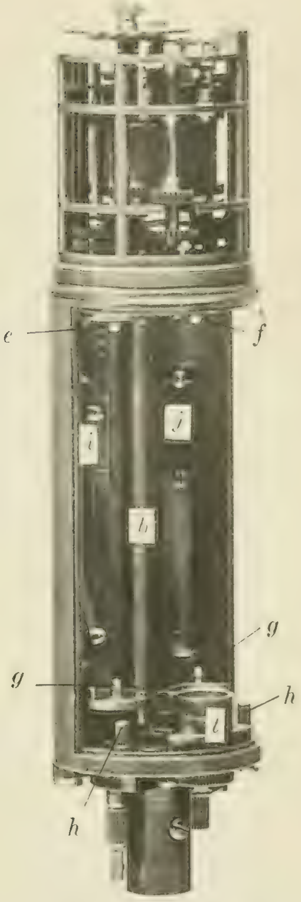
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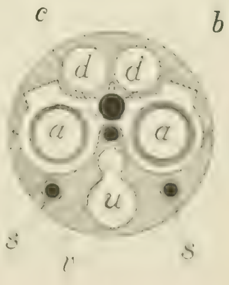
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PLATE 2.

PLATE 2.

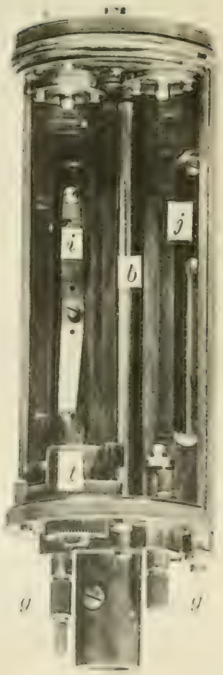
Fig. 4. Another view of main casting shown in Fig. 2.

Fig. 5. View of interior of the front casting.

Fig. 6. System of horizontal plates in the collimator.

Fig. 7. Print from original negative; silhouette of mercury column shown in white.

Figures 4, 5, and 6 have uniform scale: 47 per cent of natural size; figure 7, natural size.



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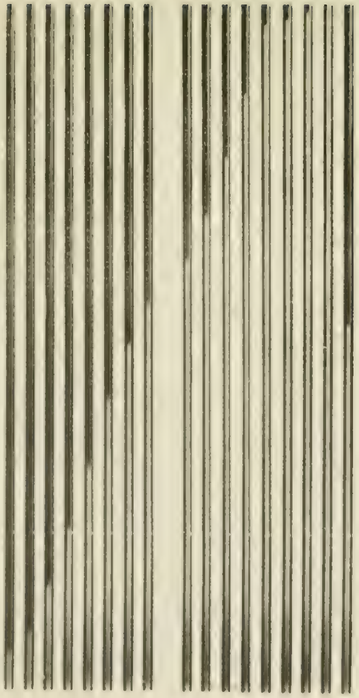

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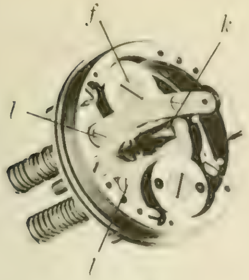
PLATE 3.

PLATE 3.

Figs. 8–11. Details of structure.

Uniform scale: 47 per cent of natural size.

[*Note.* In Fig. 8 the upper center, *e* (not lettered) is opposite the other upper center, *f*].



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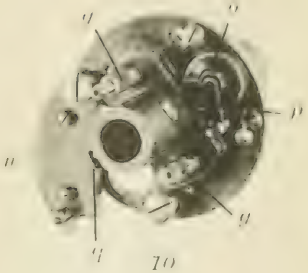

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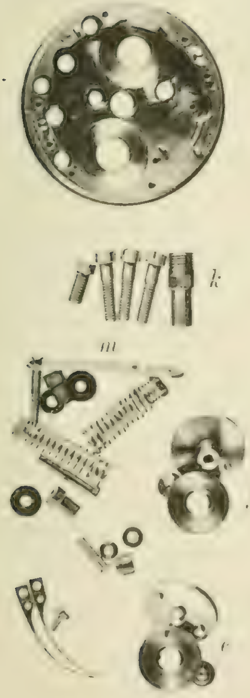

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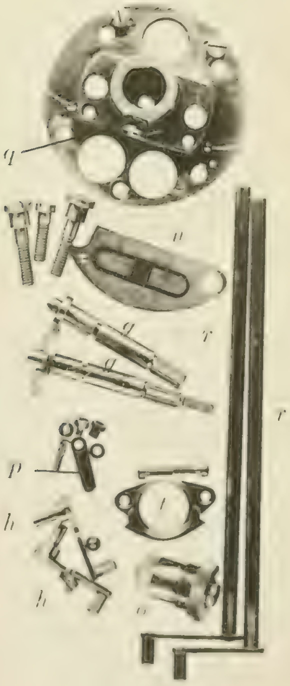
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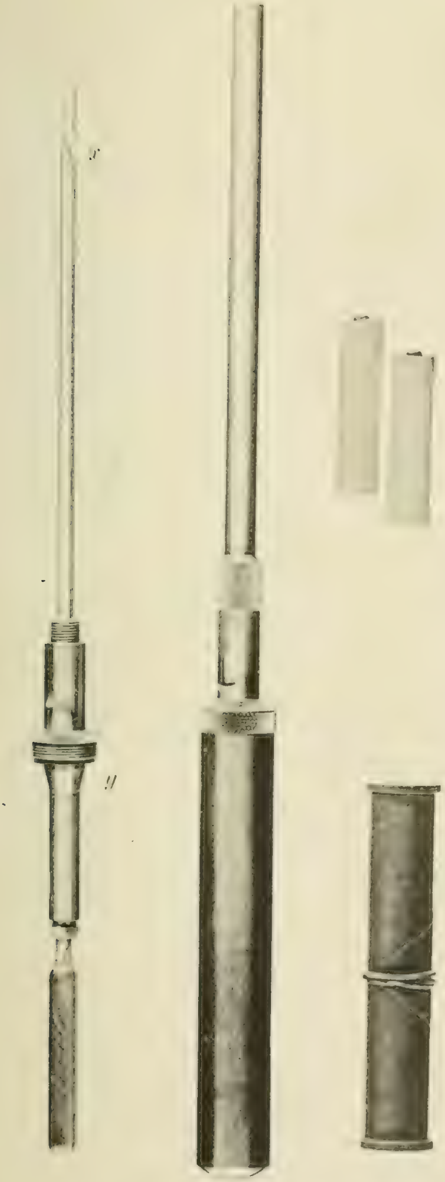
PLATE 4.

PLATE 4.

Fig. 12. The thermometer, brass case for thermometer, two dry cells, and cartridge roll of camera.

Fig. 13. Details of the clockwork.

Uniform scale: 47 per cent of natural size.



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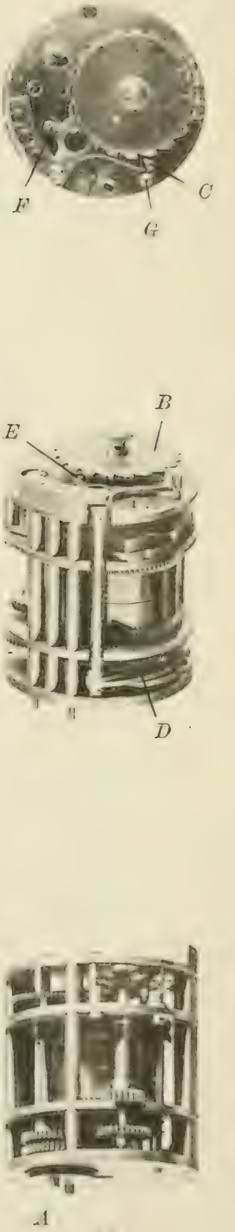

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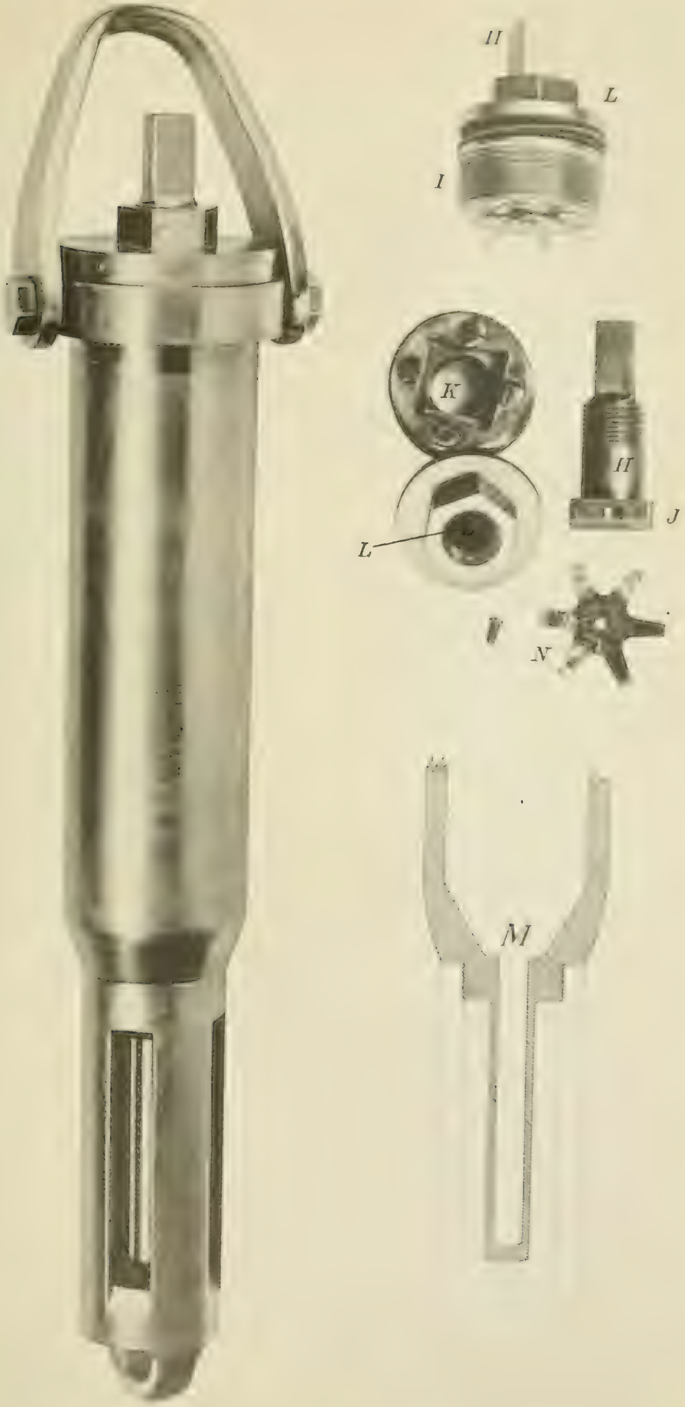
PLATE 5.

PLATE 5.

Fig. 14. Protective steel shell, detail of its parts, and section of its lower end. Uniform scale: 30 per cent of natural size.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